City of Redmond
2023 Water System Plan DRAFT

June 2023

Certificate of Engineer

This Water System Plan for the City of Redmond has been prepared under the direction of the following Registered Professional Engineer.

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Consumer Meeting

An informational meeting for the City's consumers was held as part of a City Planning Commission meeting on XX, 2023. This meets State requirements at Chapter 246-290-100 (8) (a), Washington Administrative Code.

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Appendices

Appendix A – local government consistency and agency comments with responses (pending)

Appendix B – SEPA Documentation (pending)

Appendix C – 2023 WFI

Appendix D – Interlocal Agreements

Appendix E – Cascade Water Alliance Water Use Efficiency Annual Report

Appendix F – Fire Flow Requirements from Fire Marshal (pending)

Appendix G – Water Quality Monitoring Schedule

Appendix H – Coliform Monitoring Plan

Appendix I – Disinfection By-Products Monitoring Plan

Appendix J – Annual Water Quality Report (pending)

Appendix K – Hydraulic Model Results

Appendix L – Detailed Capital Improvements Plan Map

Appendix M – 2017 Utility Rate Study Final Report

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Chapter 1: Introduction

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1. Introduction

The City of Redmond provides water service to residents and businesses located in and around Redmond, Washington. This 2023 Water System Plan (WSP) describes the City's water production and distribution facilities, operations, and compliance with state and federal drinking water regulations. This WSP also identifies capital improvements needed, as well as the City's financial plan to fund these needs. This Plan is submitted in accordance with State requirements at Chapter 246-290-100 Washington Administrative Code (WAC) and updates the prior WSP issued in 2011.

1.1. System Overview

The City of Redmond has been providing public water supply since the early 1900's. The service area includes everything within Redmond city limits as well as the Redmond Ridge and Trilogy Urban Planned Developments within unincorporated King County. The water distribution system includes four distinct service areas with differing operational characteristics. These areas are: Well Service area, Rosehill Service area, Overlake/Viewpoint Service Area; and the Novelty Hill Service area. Two of the City's four service areas are hydraulically interconnected with the City of Bellevue and City of Kirkland water systems on the south and west (Overlake/Viewpoint and Rosehill respectively). The three cities jointly own storage and pumping stations in those areas.

Water delivered to the City's customers is produced from a combination of sources, including wells owned and operated by the City as well as water produced from Seattle's Tolt River source. Redmond is a member of the Cascade Water Alliance, which delivers regional water supply contracted from Seattle Public Utilities.

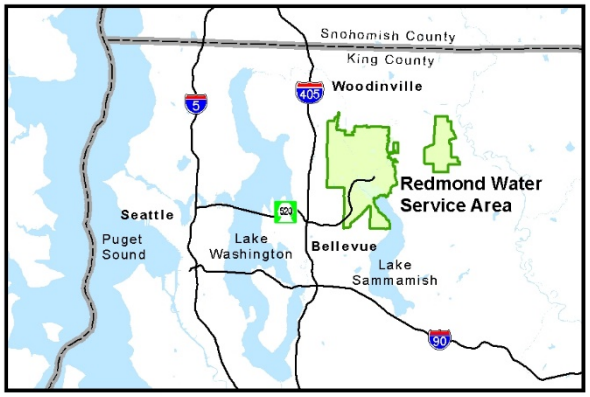

Figure 1-1. Location Map

Redmond serves a residential population of approximately 87,500. During business hours, the population served grows to approximately 132,000. Major employers receiving water from the Redmond system include Microsoft headquarters as well as many other businesses such as SpaceX, Meta, Amazon and King and Prince Seafood. The City's population and business profile has grown rapidly in recent decades, and further growth expected during the 20-year time period covered by this Plan is estimated at 39,000 additional people and 25,000 jobs.

Further information on the City's water service area, facilities and operations is presented in subsequent chapters of this WSP.

1.2. Planning Objectives

This WSP has the following objectives:

- Provide updated estimates of expected water demands in the City's service areas, to support planning for new or expanded facilities.
- Update the City's computerized model of its distribution system infrastructure to reflect construction of new water mains and other facilities. This model is a working tool used to evaluate the adequacy of existing facilities and identify needs for system improvements.
- Update the City's Capital Improvement Plan (CIP) and associated funding requirements.
- Reflect updated plans and programs of the Cascade Water Alliance. Cascade is an inter-local organization formed by seven water systems, including Redmond, to contract and develop regional water supplies for its members.
- Provide updated information on the City's operational programs, including compliance with drinking water quality and water use efficiency requirements; protection of groundwater sources from potential degradation; cross-connection control and water conservation.

1.3. Coordination with Redmond Comprehensive Plan

The Water System Plan update process began in 2020 and is designed to implement Redmond's Comprehensive Plan. The current Comprehensive Plan was adopted in 2011 with amendments adopted in 2022. An update to Redmond's Comprehensive Plan (Redmond 2050) is underway which will set the planning horizon to 2050. That process began in 2022 and is scheduled for adoption in the third quarter of 2024.

Planning staff have been involved in the draft Water System Plan update and Water Engineering staff have in turn reviewed Comprehensive Plan policy updates, especially in relation to utilities and capital facilities. Although the draft Water System Plan includes references to the currently-adopted Comprehensive Plan, it is modeled upon and compatible with anticipated findings of the 2024 update. The Comprehensive Plan's updated growth targets and expected policy revisions do not negatively impact growth forecasts provided in the updated Water System Plan. If the final recommendations of the Comprehensive Plan update significantly change the distribution of jobs and housing units within the City, the water model will be updated after plan adoption to reflect changes.

The City's Public Works department will monitor the Comprehensive Plan update process and update plans and policies as necessary in a timely manner. Redmond's Comprehensive Plan Policy CF-4 specifies the process for minor and major updates to functional plans as follows:

- For minor modifications to existing plans, administratively review changes that are consistent with and do not impede the implementation of the Comprehensive Plan.
- For major updates and new functional plans, use the Comprehensive Plan amendment review process. A major update is characterized by any of the following:
  - Amendments representing more than clarification of existing language or intent;

- Significant changes to anticipated service provision based on new analyses, assumptions or implementation strategies;
- Changes proposed by private parties that are inconsistent with or may impede implementation of the Comprehensive Plan.

1.4. Local Government Coordination

The City provided the draft WSP to local governments for their review, comment, and approval. Key local governmental bodies who have reviewed and provided comment are:

- City of Redmond Planning Department – to provide determination of consistency with City planning and policies, including Redmond 2050.
- King County Planning and Regulations Division and Utility Technical Review Committee (UTRC) – to provide determination of consistency with County planning and policies.
- Adjacent water purveyors – City of Kirkland, City of Bellevue, Northeast Sammamish Water and Sewer District, Union Hill Water Association, Sammamish Plateau Water, Woodinville Water District, and Dawnbreaker Water Association.
- Washington Department of Health – detailed technical review of all plan elements and final regulatory approver of the WSP.

Local government consistency checklists and comment-response documentation for local governments is in Appendix A.

The City has prepared an Environmental Checklist under provisions of the State Environmental Policy Act (SEPA). Based on the checklist, a Determination of Non-Significance (DNS) has been issued. The Checklist and DNS are in Appendix B.

1.5. Organization of Plan Document

Following the Executive Summary, this Water System Plan is organized into the following chapters:

Chapter 1: Introduction

Chapter 2: Service Area and Policies

Chapter 3: Water System Description

Chapter 4: Planning Data and Water Demand Forecast

Chapter 5: Water Use Efficiency Program

Chapter 6: Distribution Facilities Design and Construction Standards

Chapter 7: Water Supply Resource Evaluation

Chapter 8: Water Quality Regulations and Compliance

Chapter 9: Wellhead Protection Program

Chapter 10: Source, Storage, and Distribution System Evaluation

Chapter 11: Operation and Maintenance Program

Chapter 12: Capital Improvement Program

Chapter 13: Financial Program

The Appendices to this Plan contain further information related to these topics and are referred to in the text of each chapter where appropriate.

Chapter 2: Service Area and Policies

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2. Service Area and Policies

This section provides a general overview of Redmond's water system, including its history, a description of adjacent purveyors, characteristics of the water service area, interlocal agreements, and policies related to water service.

2.1. Ownership and Management

The City owns, operates, and manages the public water system located generally within its municipal corporate boundaries and in the Novelty Hill area northeast of the City. A copy of the City's 2023 Water Facilities Inventory (WFI) Report Form is included as Appendix C. General information required by the Washington State Department of Health (DOH) regarding the Redmond water system is summarized below:

- System Name: City of Redmond Water System
- System Type: Group A Community Public Water System
- System ID Number: 71650B
- Owner Name: City of Redmond
- Owner Type: Local Government
- Owner Number: 4821
- Owner Address: 15670 NE 85th St, Redmond, WA 98052
- Location: King County, Washington

Engineering and operations functions associated with the water system are housed in the City's Public Works Department. In addition, the City's Finance Department handles utility billing.

2.2. System Background

The City of Redmond is located approximately 10 miles east/northeast of Seattle at the north end of Lake Sammamish in King County, Washington. Redmond is bordered by the City of Bellevue to the southwest; the City of Kirkland to the west; unincorporated King County to the north, east, and southeast; and Marymoor Park (King County) and Lake Sammamish to the south. Currently, the Redmond water system provides water service to a residential population of approximately 87,500 via approximately 19,600 individual metered service connections.

Figure 2-1 shows the City's retail service area and adjacent jurisdictions. The City does not currently provide service to all areas within its retail service area, but it is anticipated that the City will serve this area within the 20-year planning period of this Plan.

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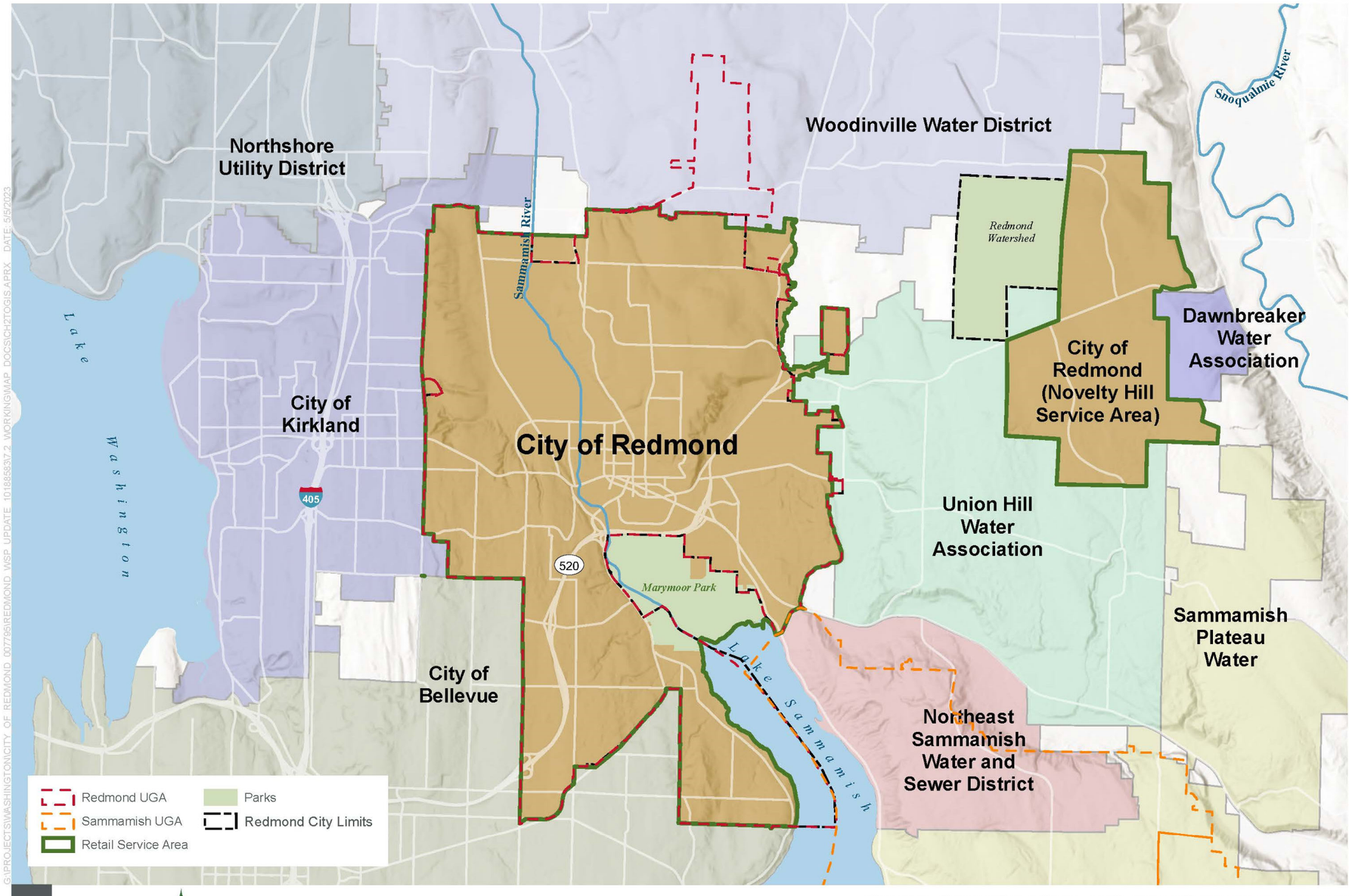

Figure 2-1. Retail Service Area and Adjacent Purveyors

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2.2.1. Water System Overview and Development History

The Redmond water system currently supplies its water customers through four hydraulically distinct but interrelated service areas. These include the Well Service Area, the Rose Hill Service Area, the Overlake/Viewpoint Service Area, and the Novelty Hill Service Area. The three Service Areas located within Redmond's city limits are shown in Figure 2-2. Development of the water system in what is now referred to as the City's Well Service Area dates back to the early 1900s.

The Overlake/Viewpoint Service Area was originally served by a water district that was assumed by Redmond and Bellevue as the cities expanded. Water system development in this Service Area began in the 1950s. Water service was extended throughout Viewpoint in the late 1960's through a local improvement district.

The City's Rose Hill Service Area was served by the Rose Hill Water District until 1994 when ownership and operation of the District water system was assumed by, and divided among, the cities of Bellevue, Kirkland, and Redmond.

Service to the Novelty Hill Service Area began in the late 1990s to serve the Redmond Ridge and Trilogy Urban Planned Developments northeast of the City in unincorporated King County along Novelty Hill Road.

Additional history of the Redmond water system and associated facilities is provided in the following sections.

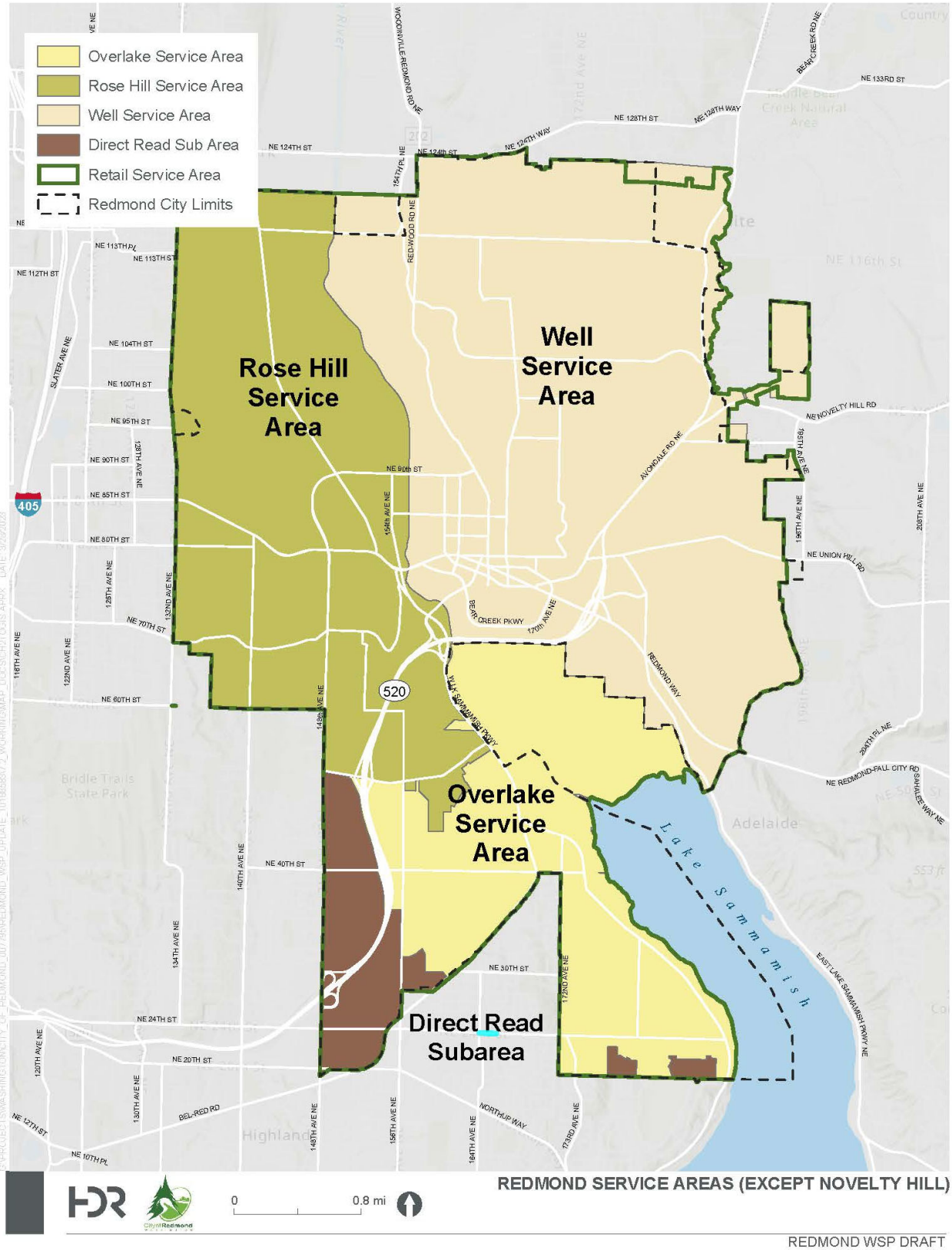

Figure 2-2. Redmond Service Areas (Except Novelty Hill)

Well Service Area

Redmond's earliest water system development was focused in and around what is now the Well Service Area. The City's first official public source of drinking water was Perrigo Springs, acquired and developed in 1914. The early water system included the spring, a dam forming a storage reservoir, and distribution piping consisting of four-inch to eight-inch wood stave pipe serving what is now the downtown area. In 1923, the Town of Redmond acquired 40 acres of watershed above the spring to protect water quality. This property is now the site of Jonathan Hartman Park. The original wood stave pipe was replaced with cast iron pipe in 1933.

In 1926, the town started action towards providing a second source of supply by acquiring approximately 800 acres of watershed on Seidel Creek. Water rights to Seidel Creek were acquired in 1927. Two dams and a pipeline were constructed to augment the spring supply with surface water from the creek. However, the dams washed out and the water quality of the creek source frequently did not comply with health department requirements, so in 1953 the town stopped using the Seidel Creek source and returned to the spring as its primary source of water. The spring and associated facilities continued to serve the community until 1962.

Significant additions were made to the water system in 1952. Well No. 1, with a capacity of 200 gpm, was developed in Anderson Park, and a 0.25-MG wood-stave tank was constructed at the Nike site to provide additional storage. In order to support growth and development on Education Hill, a pump station and additional pipelines were also constructed. Well No. 2 was drilled in 1959 at Anderson Park, adding another 500 gpm of supply capacity to the system.

A variety of major water system facilities were added to the system in 1962. Well No. 3, with a capacity of 350 gpm, was constructed east of Avondale Road NE, a 2.0-MG steel reservoir was constructed on Education Hill, and a 0.5-MG steel reservoir and pump station were constructed at the Perrigo Springs site. Also water service to the higher elevations of Education Hill was enhanced through the construction of a pump station.

In 1972, Well No. 1 was reconstructed, expanding its capacity to 700 gpm, and Well No. 4, with a capacity of 750 gpm, was constructed. The 4.0-MG Reservoir Park concrete reservoir and pump station were constructed in 1975 and 1976. Well No. 5, located in southeast Redmond, was constructed in 1984, adding an additional 1,000 gpm to the City's groundwater supply capacity.

Faced with the need to develop additional source capacity, the City negotiated a short-term wholesale supply contract with the Rose Hill Water District, which was then supplying water within Redmond along the western slopes of the Sammamish River Valley. Two metered interties were developed to connect the Redmond system with the Rose Hill Service Area. The capacity of these two interties was limited to approximately 1,100 gpm due to hydraulic limitations in the Rose Hill service area. These interties were re-designated as meter stations when the City assumed part of the Rose Hill Water District.

In 1988, Well No. 4 was demolished, a second 3.0-MG steel reservoir was constructed at the Education Hill site, and the small pump station serving the higher elevation of Education Hill was refurbished. In 1989, the City of Redmond finalized an agreement with the City of Seattle to purchase water from the Seattle supply system. This agreement initiated construction of Phase 1 of Seattle's Tolt Pipeline No. 2, which went into operation late in the summer of 1990. Redmond's connection to this pipeline was sized initially for 6.0 million gallons per day (mgd) of

supply capacity, and is expandable to approximately 12.0 mgd. Phase 2 of Seattle's Tolt Pipeline No. 2, completed in 2000, provided two stubs for future connections.

In 1989, service to Southeast Redmond was enhanced through the construction of the Southeast Redmond Pump Station. Additional storage capacity was added to that area in 1996 with the construction of a 4.5-MG steel Southeast Redmond Reservoir.

In 1997, a new larger Education Hill Pump Station was constructed to replace the original small pump station that served the higher elevations of Education Hill. In 2000, a third intertie between the Rose Hill Service area and the Well Service Area was constructed.

In 2000, the City began a source improvement project to upgrade all five wells. Well No. 4 was rebuilt in 2003, including upgraded treatment systems. Well Nos. 3 and 5 were upgraded to include new well house structures, pumps, mechanical and electrical equipment, and chemical-feed systems. The Well No. 5 upgrade was completed in 2005, and the Well No. 3 upgrade was completed in 2008. Similar upgrades to Well Nos. 1 and 2 were completed in 2009.

In 2008, the City completed significant maintenance of reservoirs within this service area, including seismic upgrades and painting of the two Education Hill tanks. Both tanks now meet current safety, operational, and seismic requirements. The Perrigo Springs tank was painted and had handrails added. The second Tolt supply station and meter at 172nd Street were finished. In addition, developer extensions added distribution piping north of 116th Street.

In 2014 Well 4 was redeveloped and the casing cleaned in an effort to improve performance of the well and water quality.

In 2020 the Southeast Redmond Reservoir was provided with seismic upgrades and repainted.

Rose Hill Service Area

Water service to the Rose Hill Service Area on the western slopes of the Sammamish River Valley was provided by the Rose Hill Water District until 1994, when the district's water system was assumed by and divided among the cities of Bellevue, Kirkland, and Redmond. Assumption of the Rose Hill Water District significantly expanded the Redmond water system. The Rose Hill Service Area was essentially divided among Bellevue, Kirkland, and Redmond based on their ultimate city limits, with the municipalities assuming ownership of those portions of the system within their respective water service areas and corporate boundaries. Despite the fact that the ownership of the Rose Hill Service Area is now divided, the Rose Hill Service Area remains hydraulically connected and essentially intact. Although each of the three cities maintains responsibility for its portion of the Rose Hill distribution system, the major Rose Hill water system facilities, including the supply, storage, and pumping installations, are owned and operated jointly by the three cities.

The primary source of supply for the Rose Hill Service Area is Seattle's Tolt Eastside Supply Line (TESSL). The Rose Hill Service Area is currently supplied from three metered supply interties (supply stations) to the TESSL: Supply Station No. 1 located at NE 70th Street and 140th Avenue NE, Supply Station No. 2 located at NE 85th Street and 132nd Avenue NE, and Supply Station No. 3 located at NE 116th Street and 132nd Avenue NE.

The system shares two water tanks and two pump stations. The Bellevue/ Kirkland/Redmond 11.2-MG steel South Reservoir and Kirkland/Redmond South Reservoir Pump Station were built

in 1971 and 1968, respectively. The pump station was replaced in 2004 with a new facility capable of providing 5,250 gpm. The North Reservoir was repaired after a floor plate leak that was caused by the 2001 Nisqually earthquake.

The Kirkland/Redmond 14.3-MG steel North Reservoir and the North Reservoir Pump Station were built in 1994. Major modifications were completed in 2010.

The Rose Hill Service Area also includes six metered connections with adjacent service areas: a meter to Bellevue located at NE 60th Street and 140th Avenue NE, placed into service in 1983, a meter to the 520 zone of the Overlake/Viewpoint service area located near NE 51st Street and 156th Avenue NE, a meter to the 335 zone of the Overlake/Viewpoint service area along West Lake Sammamish Parkway NE near NE 51st Street, and the three connections to Redmond's Well Service Area discussed previously.

In 2009, a small area in unincorporated King County and the southwest corner of Redmond's service area was transferred to the City of Kirkland after it was annexed by Kirkland. Another area of Redmond's service area in King County being annexed by the City of Kirkland is the northwest corner, north of NE 124th Street. This area was annexed by Kirkland in 2012 with the water service being transferred to Kirkland shortly after.

Overlake/Viewpoint Service Area

Redmond's Overlake/Viewpoint Service Area is served by joint Bellevue/Redmond facilities with Bellevue's water system and its various connections to the TESSL acting as the primary source of supply since the 1960s. The Redmond Overlake/Viewpoint Service Area is hydraulically interconnected with the Bellevue water system extending to the west and southwest. These areas are identified in Figure 2-2 as the Direct Read Subareas. In general, the majority of the water served in Redmond's Overlake/Viewpoint Service Area is supplied from Bellevue's NE 40th Street connection to the TESSL, located near 140th Avenue NE, although other Bellevue connections with the Seattle system located further to the south also contribute. This area was originally served by small water districts that have long since been assumed by the cities of Redmond and Bellevue.

Areas served by Redmond have been separated from those of Bellevue by three meters within the system: one along NE 40th Street east of SR520, one along 156th Avenue NE at NE 36th Street, and one at 171st Avenue NE and NE 24th Street. On an emergency basis, the area can also be served from the Rose Hill Service Area to the north through a number of piping connections and a meter located at 156th Avenue NE and NE 51st Street. There is also a meter on Bellevue-Redmond Road that allows water to flow back into Bellevue from Redmond.

Storage for the system is provided by the joint Bellevue/Redmond 6.0-MG pre-stressed concrete NE 40th Street Reservoir, which supplies the system through the NE 40th Street Reservoir Pump Station from its location in North Bellevue Community Park between 140th and 148th Avenues NE. Additional storage for Bellevue's portion of the system is provided by tanks located further south at the Lake Hills, Eastgate Park site, and Newport sites.

The Viewpoint area along the shores of Lake Sammamish receives additional supply through a meter to the Rose Hill service area at NE 51st Street and West Lake Sammamish Parkway.

Novelty Hill Service Area

The Novelty Hill Service Area provides water service to the Redmond Ridge, Redmond Ridge East, and Trilogy developments northeast of Redmond along Novelty Hill Road. The Novelty Hill Service Area is supplied through a metered connection to the Seattle Tolt Tie Line along 236th Avenue NE. Water can be supplied to this connection from either of two regional pipelines: Tolt Nos. 1 or 2.

The Novelty Hill Pump Station supplies the service area from the Tolt Tie Line should pressures in the Tie Line fall below the level required to supply the 730 pressure zone by gravity. Water storage for the Novelty Hill Service Area is provided by the 3.0-MG and 5.5-MG steel Novelty Hill Reservoirs.

Three metered emergency interties exist between the service area and the Union Hill Water Association water system. Two other metered emergency interties exist between the service area and Woodinville Water District. In addition, water from this service area is wheeled to Sammamish Plateau Water and Sewer District through a metered intertie connection.

2.2.2. Neighboring and Adjacent Purveyors

The City of Redmond's adjacent water purveyors include the cities of Bellevue and Kirkland, the Northeast Sammamish Sewer and Water District, the Union Hill Water Association, Northshore Water District, and the Woodinville Water District. Figure 2-1 identifies each purveyor and its location relative to the Redmond water system. In addition to those shown, several smaller water systems and a number of private wells are in operation in the Redmond vicinity. Also, adjacent to the Novelty Hill service area are the Union Hill Water Association, Sammamish Plateau Water and Sewer District and Dawnbreaker Water Asssociation water systems.

2.3. Related Plans

The City's program to ensure a comprehensive and reliable system for delivering water supply to its customers is embedded in a larger network of plans, policies and agreements that address land use and water supply within King County. This chapter provides a brief description of selected plans that relate to the City's water system.

2.3.1. 2016 King County Comprehensive Plan

The King County Comprehensive Plan is the guiding policy document for all land use and development regulations in unincorporated King County, and for regional services throughout the County. The current plan was adopted in December 2016 and updated in July 2020. This plan guides growth and development in the unincorporated areas of King County through 2031.

Key topics in King County's Comprehensive Plan that are relevant to this Water System Plan include: regional planning, land use, utilities, and capital facilities. A summary of these sections and their relevance to and consistency with this Plan is provided below.

Regional Planning

The Growth Management Act requires that counties and cities develop a set of framework policies to guide development of each jurisdiction's comprehensive plan. Countywide planning is conducted by King County in cooperation with the cities to address a wide range of issues

that affect the entire county. The Countywide Planning Policies, adopted by the Metropolitan King County Council and ratified by the cities within the county, are revised on an ongoing basis to implement the Growth Management Act and to meet the state requirement for countywide planning.

The Countywide Planning Policies describe an overall vision for the cities and unincorporated portions of King County and provide general strategies and approaches to be used by local jurisdictions, acting individually and cooperatively, to achieve that vision. King County and cities like Redmond are responsible for ensuring that their respective comprehensive plans are consistent with and implement the Countywide Planning Policies. As the regional government, King County provides leadership on issues of countywide importance. The county emphasizes implementation of the Countywide Planning Policies when engaged in planning and negotiating activities with cities and other service providers, such as annexations and interlocal agreements. Redmond's comprehensive and water system planning processes are consistent with the Countywide Planning Policies.

Land Use

The City considers the King County Comprehensive Plan in its decision making for water service provided within King County unincorporated areas. Land use designations in unincorporated areas and the size and location of the Urban Growth Area (UGA) are determined solely by King County. The UGA and its relationship to the City's water retail service area are shown in Figure 2-1.

Figure 2-3 shows the land use designations identified in the King County Comprehensive Plan.

The UGA includes all cities within the county, the cities' annexation areas, and land within the unincorporated part of the county characterized by urban-type growth. Cities are then expected to ultimately annex areas within their respective UGAs and to plan for service delivery for these areas.

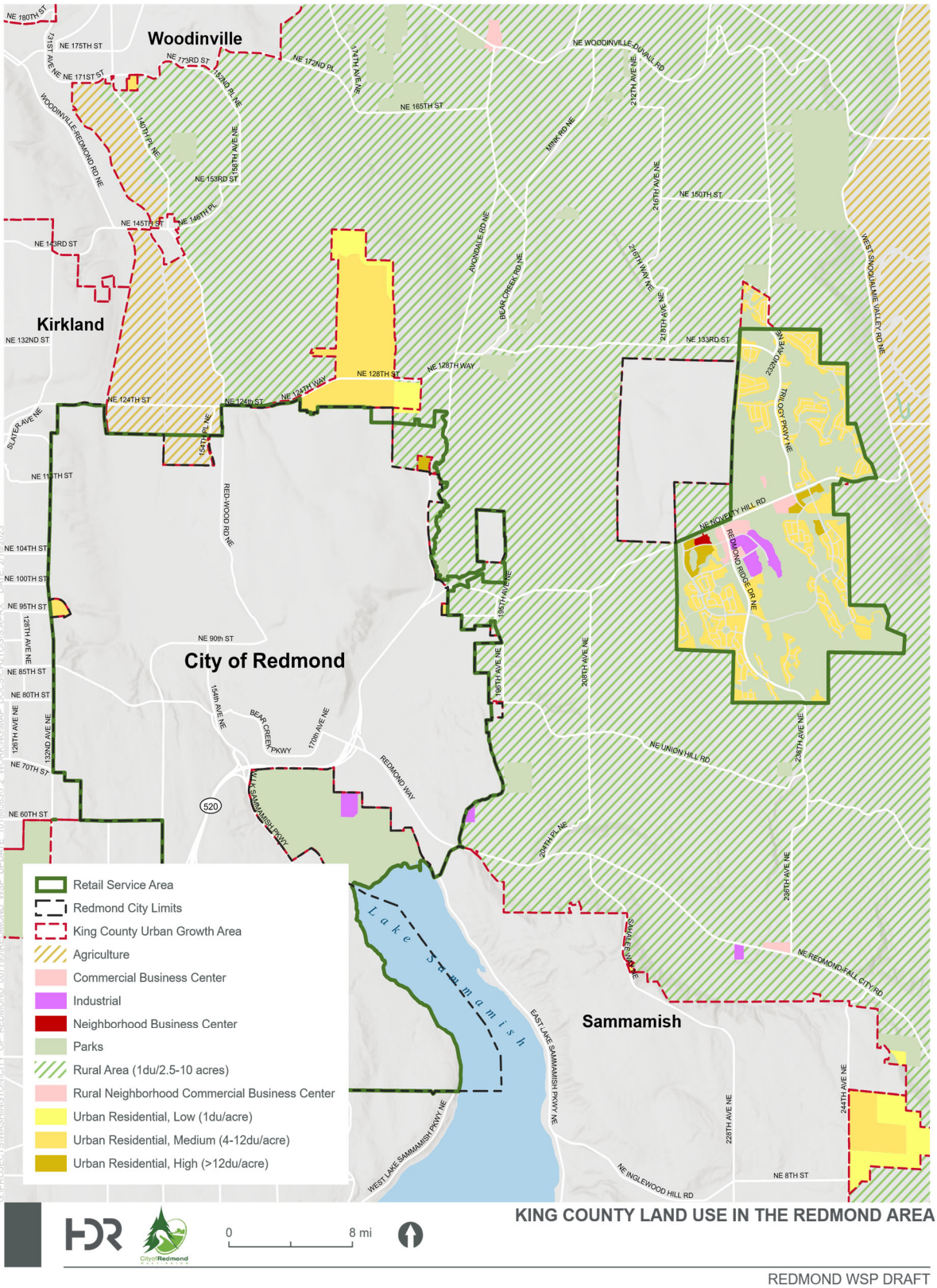

Figure 2-3. King County Land Use In the Redmond Area

The King County Comprehensive Plan provides projections for household and employment growth through the year 2031. Per those projections, Redmond is expected to accommodate an additional 10,200 households within the City and an additional 640 households in the City's Potential Annexation Areas between the years 2006 and 2031. Redmond is expected to accommodate 23,000 jobs between 2006 and 2031. The City of Redmond, with Puget Sound Regional Council, has continually monitored and updated its household and employment projections following adoption of the King County Comprehensive Plan. Therefore, the most up-to-date projections used in this WSP do not align exactly with those described in the current King County Comprehensive Plan.

King County has set a long-term goal for housing density in urban communities of an average eight homes per acre. The Comprehensive Plan states that single-family homes will continue to account for most of the new development in the County, while a wide range of housing densities and types will be encouraged. Further, the Comprehensive Plan states that King County should apply a minimum density requirement of four units per acre to all urban residential zones, except under limited circumstances such as significant physical constraints or property-specific conditions. In cases where areas are proposed for rezone to increase density, King County will notify cities and utility providers and should work with these service providers on issues raised by the proposal. The Comprehensive Plan states that residential developments within the UGA will connect to the City's system.

King County has developed a coordinated review process for Urban Planned Developments (UPDs). Large land ownerships within the UGA may be designated as UPDs to offer the public and the property owner opportunities to realize mutual benefits. Possible public benefits include greater preservation of public open space, proponent contributions to major capital improvement needs, diversity in housing types and affordability, and the establishment of the specific range and intensity of uses for the entire UPD. A property owner and the public could benefit from the efficiency of combined hearings and land use decision making, as well as the establishment of comprehensive and consistently applied project-wide mitigations guiding the review of subsequent land use approvals.

King County has designated the Bear Creek UPD area near Redmond. The Bear Creek UPD is comprised of Redmond Ridge UPD, Trilogy at Redmond Ridge UPD, and the Redmond Ridge East UPD. The Redmond Ridge, Trilogy and Redmond Ridge East UPD sites have been developed at urban densities.

The Growth Management Act allows counties to establish a process, as part of the UGA designation, for reviewing proposals to authorize new Fully Contained Communities (FCC). Criteria for approval of FCCs are contained in RCW 36.70A.350. If a county establishes in its comprehensive plan a process for authorizing FCCs, it must adopt procedures for approving FCCs in its development regulations. King County has established a fully contained community, consisting of the Bear Creek UPD area. City of Redmond provides water and sewer service to this area.

The King County Comprehensive Plan promotes annexation of urban unincorporated areas. Much of the County's urban unincorporated area is made up of geographically isolated islands surrounded by cities or adjacent to the urban growth boundary. Because these areas are scattered across the county, the provision of local services is costly. The lack of a substantive urban unincorporated area tax base exacerbates these difficulties and covering the cost of serving these areas reduces the amount of revenue available for regional services and for local services in the Rural Area. Therefore, King County has a strong fiscal interest in seeing the

remaining urban unincorporated areas be annexed to cities in the next several years. The Comprehensive Plan further states that cities are the appropriate providers of local public services to all areas within the UGA, and that annexation is a means to achieve that desired service.

Utilities

The King County Comprehensive Plan describes King County's approach to water supply planning, and states that King County is not a water utility and does not provide potable water to customers in the region. However, it plays an important role in the coordination or linking of water supply and growth. Moreover, the county reclaims water from its wastewater treatment plants. Reclaimed water can be used for many purposes, subject to protections for surface and groundwater, such as irrigation outside of critical aquifer recharge areas, and industrial use, which currently utilize potable water sources.

The King County Plan states that, over the past several years, King County has been working cooperatively with many of the larger water utilities in the region to gather information about regional water demand and supply.

Water utility service areas in King County are described in Coordinated Water System Plans (CWSPs) developed under the Public Water System Coordination Act (chapter 70.116 RCW) and individual water system plans (WSPs) such as this Plan. CWSPs describe future service areas for water utilities within which they are provided the exclusive right to serve future customers, and are to include the means for meeting those needs in the most efficient manner possible.

Under state law (RCW 43.20.260), the water utility is required to provide service within its retail service area, provided it can meet the conditions prescribed in state law, including the ability to deliver such service in a timely and reasonable manner. Individual WSPs must include the water utility's retail service area, which includes existing customers and areas where the utility plans future service. The planned provision of service must be consistent with local government comprehensive plans, land use plans, and development regulations. The Comprehensive Plan states that other service providers may serve within the future service area of a designated water utility if the designated water utility is unable to provide service in a timely and reasonable manner.

The King County Comprehensive Plan includes policies F-232 through F-237, which relate to potable water systems serving unincorporated areas within the UGA.

As part of its resource management and land use planning responsibilities, the King County Utilities Technical Review Committee reviews water system plans for those water utilities serving unincorporated King County or otherwise subject to the planning requirements of K.C.C. 13.24 and ensures the inclusion of elements related to reclaimed water, water use efficiency, and water conservation in the plans as may be called for under state law, the King County Code, or the King County Comprehensive Plan.

The King County Comprehensive Plan includes policies F-251 and F-252 related to ensuring consistency with WSPs.

2.3.2. City of Redmond Comprehensive Plan

The City's Comprehensive Plan, updated in 2011, provides a framework for decisions on growth, land use, transportation, public facilities and services, parks and recreation, resource lands, and critical areas through the year 2030. The Comprehensive Plan was developed pursuant to the State Growth Management Act (GMA). During development of this Water System Plan, the City was updating its Comprehensive Plan to correspond to the publication of the Puget Sound Regional Council VISION 2050 plan. The VISION 2050 plan provides regional planning guidance for a four-county region in the central Puget Sound, which includes King County. City planning is using VISION 2050 to guide development of the next City Comprehensive Plan. Redmond recognizes that the new Comprehensive Plan will contain updated growth projections and the City will incorporate those updated projections into the WSP after the updated Comprehensive Plan is complete.

Key topics addressed by the Comprehensive Plan that are relevant to the City's water system include land use, housing, capital facilities, and utilities. A summary of these Comprehensive Plan elements and their relevance to and consistency with this Plan are provided below.

Land Use

The land use element of the Redmond Comprehensive Plan (see Figure 2-4) is designed to help Redmond achieve its vision for a city that has gracefully accommodated growth and change, while ensuring that the community's high quality of life, cherished natural features, and distinct places and character are retained. The land use element provides the basis for planning for this growth, including needs for water service and infrastructure.

The Comprehensive Plan recognizes that resource and rural lands adjacent to urban areas historically have experienced pressure to develop at higher densities. Proximity to the City or potential annexation areas can raise property owner expectations that more intense development may be allowed and may discourage investments in resource or rural land uses. Extension of public facilities can encourage conversion of agricultural or rural lands. In light of these pressures for change, potential adverse impacts, and Redmond's strong interest in long-term preservation of these areas, the City's land use policies are designed to assure preservation of rural areas and agricultural areas adjacent to the City.

The Comprehensive Plan indicates that these land use goals are reflected in the city's land use regulations and zoning code. The Comprehensive Plan identifies six main categories of land use: Residential, Commercial, Urban and Local Centers (e.g., Downtown/Overlake), Other Employment (business park/manufacturing), Design District (Bear Creek and Southeast Redmond), and Urban Recreation/Semirural. Each of these is subdivided into land use designations, which are further defined by the City's zoning code.

Figure 2-5 shows the City's zoning.

Housing

The housing element of the Redmond Comprehensive Plan combines community values, legislative directives, and regional cooperation to form a set of policies that will ensure that Redmond grows gracefully, retaining elements of its past while preparing for the future. The housing element focuses on Redmond's housing supply including policies regarding the

jobs/housing balance and design standards. It also focuses on housing diversity with policies regarding innovative zones, affordability, and incentive programs.

The Countywide Planning Policies establish job and housing targets for each sub-region in King County (see Section 2.3.1). The percent of jobs forecast in the Countywide Planning Policies determines the corresponding number of housing units that must also be accommodated within each sub-region. The CPPs state that, by the year 2031, Redmond expects to accommodate 10,840 additional housing units. As mentioned in section 2.3.1, these projections do not directly align with the growth projections used in this WSP due to regular analysis, including actual growth data, and updates of demographic projections for specific purposes.

While many neighborhoods in Redmond are nearly fully developed, other areas such as North Redmond, Southeast Redmond, and portions of the Willows/Rose Hill neighborhood still contain large undeveloped parcels of land. For the more fully developed neighborhoods, infill, redevelopment, and remodeling of existing homes will be the primary force affecting neighborhood quality. Redmond's Comprehensive Plan describes the City's abilities to achieve its share of the sub-region's housing target as highly dependent on the City achieving the mix of offices and housing that is planned for the mixed-use areas of Downtown, Marymoor and Overlake.

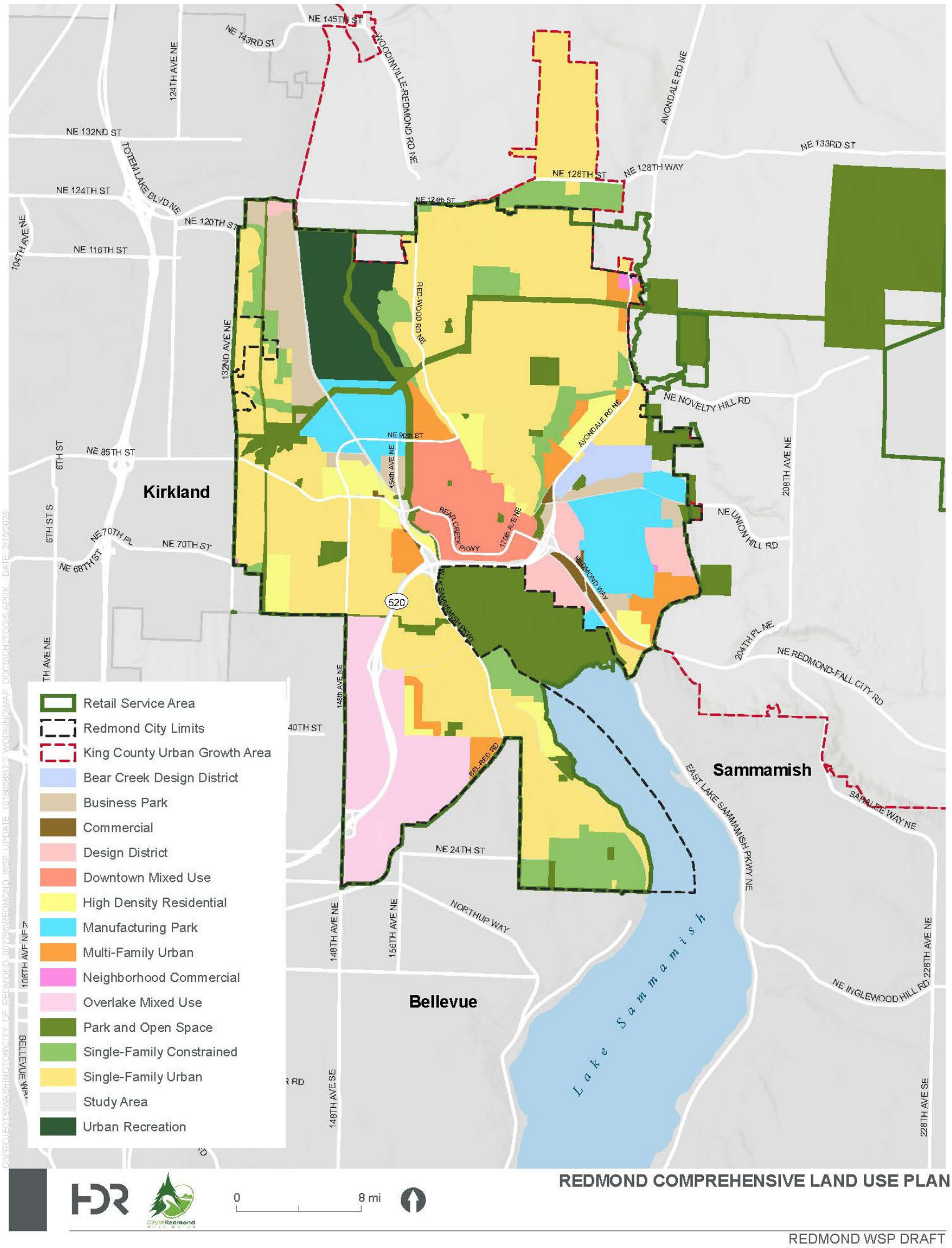

Figure 2-4. Redmond Comprehensive Land Use Plan

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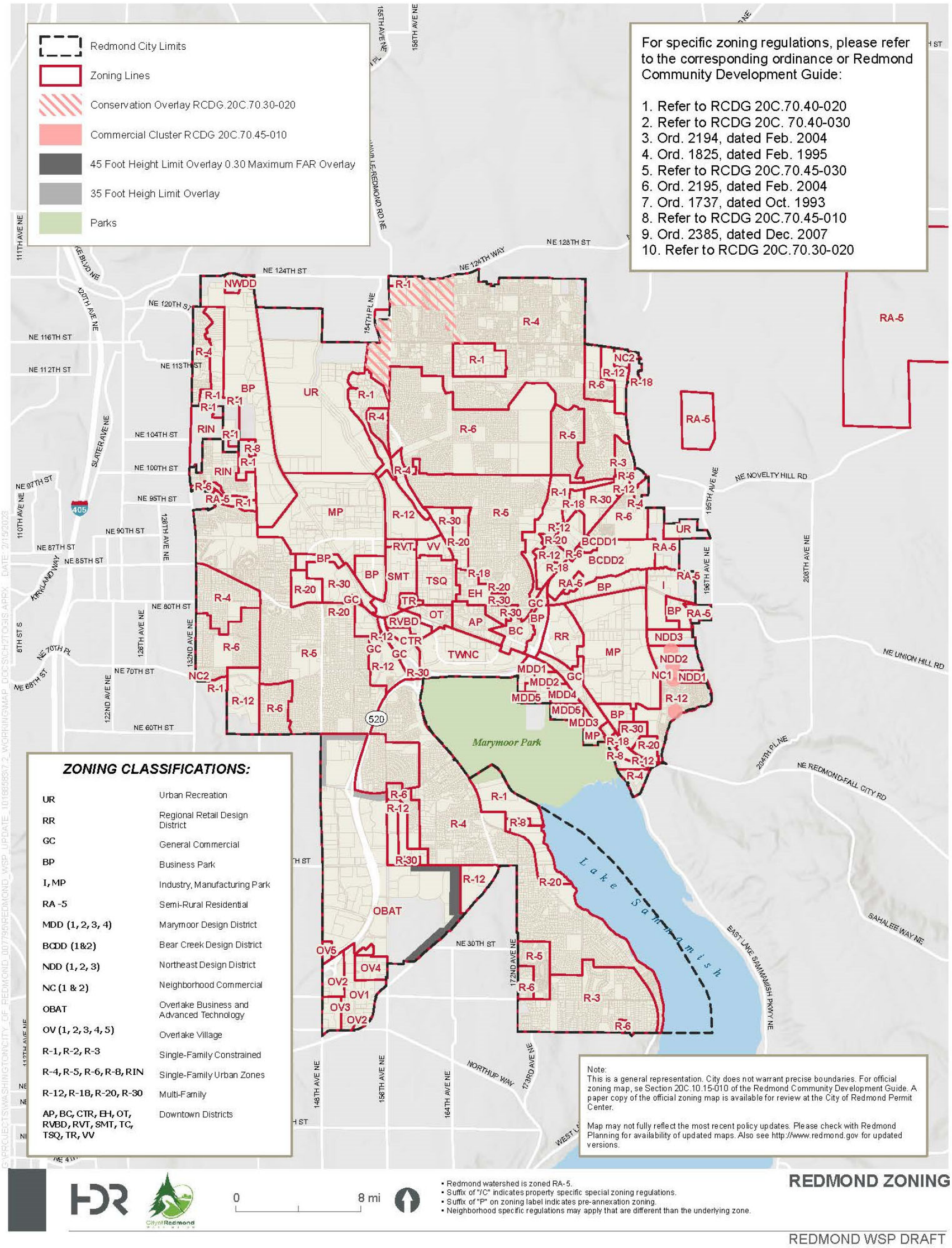

Figure 2-5. Redmond Zoning

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Capital Facilities

Redmond's Comprehensive Plan states that the City must plan for capital facilities in order to meet the need created by future growth and to maintain current levels-of-service. Capital facilities include water service infrastructure, as well as fire and police facilities, roads, sewers, stormwater facilities, and more. Each type of facility is designed or built to provide a certain level-of-service to the community, as noted in the capital facilities element. This element takes stock of capital facility inventory, establishes a capital facilities plan, and sets policy on how the City can finance capital facilities in the long term.

The Comprehensive Plan recognizes that the cost of maintaining Redmond's quality services and facilities must be borne equitably. Redmond continues to draw from diverse revenue streams in order to finance capital facility projects. The public facility costs associated with new growth are recovered in part using impact fees that reflect up to date costs, including those related to land and construction. In addition, the City continues to seek grants and other outside funding in order to maintain its high quality of life. Redmond relies on the analysis of needed capital improvements completed as part of this Plan (see Chapter 12) to inform the City's capital facilities plan.

The following Comprehensive Plan policies guide the City's planning for capital facilities (these are abbreviated from the full text contained in the Comprehensive Plan):

- **CF-1:** Develop and regularly update functional plans that assess capital facility needs and strategies for addressing such needs. Provide opportunities for public involvement appropriate to the nature of the update. Use functional plans to guide the development of capital priorities and investment decisions.
- **CF-2**: Include in the functional plans, at a minimum, the features necessary for maintaining an accurate account of long-term capital facility needs and associated costs to the City, and consistency with the Comprehensive Plan and the Redmond Zoning Code.
- **CF-3**: Adopt by reference sections of functional plans that respond to Growth Management Act requirements as components of the Capital Facilities Element of the Comprehensive Plan.
- **CF-4**: Require that new functional plans and updates to existing functional plans adhere to appropriate review processes described in the Comprehensive Plan.
- **CF-5**: Require that properties, when they develop or redevelop, construct or contribute to improvements as identified in adopted plans.
- **CF-6**: Establish capital facility service standards that help determine long-term capital facility and funding requirements.
- **CF-7**: Develop and maintain a strategic plan for implementing capital projects in support of the City's land use vision as described by the Comprehensive Plan.
- **CF-8**: Ensure the Capital Investment Strategy fits the standards described in the Comprehensive Plan.
- **CF-9**: Define "plan-level financial balance" as the financial capability to construct adequate capital facilities at the time that they are required, in support of growth anticipated by the adopted Comprehensive Plan through the planning period to 2030, and beyond to the build-out year.
- **CF-10**: Biennially evaluate the City's ability to achieve "plan-level-financial balance." Take one or more of the following actions if the financial capacity to provide necessary capital facilities for all or part of the City is found to be insufficient.

- **CF-11**: Adopt the City's Six-Year Capital Improvement Program (CIP) as the short-term budgetary process for implementing the long-term Capital Facility Plan (CFP). Ensure that project priorities, funding allocations, and financing strategies incorporated in the CIP are consistent with the long-term CFP.
- **CF-12**: Use capital facilities to attract growth by prioritizing projects that provide service to Redmond's urban centers and/or increase mobility to/from urban centers.
- **CF-13**: Prepare a long-range revenue forecast to promote consistency and stability in capital planning and programming, as well as to inform the Budgeting by Priorities process and Capital Investment Strategic Plan.
- **CF-14**: Follow the principle that growth shall pay for the growth-related portion of capital facilities.
- **CF-15**: Aggressively pursue funding from other levels of government and private agencies to accomplish the City of Redmond's capital investment program while optimizing use of City resources.
- **CF-16**: Consider exempting from payment of impact fees certain developments that have broad public purpose when adopting an impact fee ordinance.
- **CF-17**: Require school districts that propose to have the City of Redmond impose impact fees for them to prepare Capital Facility Plans.
- **CF-18:** Identify lands useful for public purposes in functional plans and in the appropriate elements of the Comprehensive Plan.
- **CF-19:** Identify shared needs and the lands the may be used to meet these needs with nearby cities, King County, neighboring counties, the State of Washington, the PSRC, school districts, special purpose districts and other government agencies.

Utilities

The utilities element describes the planning of utilities needed to support the community's vision for the location and amount of future growth. Utility planning for future annexation areas and higher growth areas such as Downtown and Overlake has advanced achievement of the vision. The City provides certain utilities in support of the desired location and pace of growth. For those utilities provided by private companies, the City has encouraged the necessary and desired services by allowing private companies to use public facilities, ensuring sufficient areas for placement of those facilities, and providing for a reasonable regulatory climate. For example, cell service carriers have installed infrastructure on top of reservoirs as these tend to be good locations for cellular infrastructure. The City and the service carriers stay in contact to coordinate access to the facilities.

The Comprehensive Plan recognizes the importance of design standards that ensure new water facilities will be compatible with the City's overall water system and have a reasonable economic life. The utilities element reflects this in policies that require new development to construct water system improvements necessary to serve the development and to provide a reliable integrated distribution system, and to maintain adequate storage facilities to meet equalizing and fire demand volume and emergency supply.

The following Comprehensive Plan policies guide the City's planning for utilities (these are abbreviated from the full text contained in the Comprehensive Plan):

- **UT-1**: Ensure that adequate public utilities and facilities are planned for, located, extended, and sized consistent with the planned growth described in the Vision and Goals, Annexation and Regional Planning, and Land Use Elements.

- **UT-2**: Design public utility facilities to meet service standards identified in the Capital Facilities Element.
- **UT-3**: Encourage the use of innovative technologies to provide, improve and maintain utility services, reduce negative impacts of additional utility service demands, improve the existing service and reduce, where appropriate, the overall demand on utility systems.
- **UT-4**: Prevent extension of City-provided urban utilities to rural areas outside the Urban Growth Area except to meet State Department of Health or other applicable health, safety, and welfare codes. Design such extensions to rural standards and do not condition the extension with other urban development standards such as street widening, sidewalks, or street lighting.
- **UT-5**: If utility extension to an unincorporated area becomes necessary and immediate annexation is not possible, condition extension with an agreement to annex in a timely manner and an agreement to design the extension to City development standards.
- **UT-6**: Conduct City business in a manner that leads by example through activities such as recycling, water conservation, energy conservation, and low-impact development processes whenever possible.
- **UT-7**: Require development to pay for or construct the growth-related portion of infrastructure needs.
- **UT-8**: Create equity in financing of capital facilities among City residents and those outside the City by reflecting the full cost of providing service outside City limits.
- **UT-9**: Promote the efficiency of utility placement both in cost and timing through methods such as co-locating public and private facilities in shared utility corridors; coordinating facility planning; providing timely notice and permitting for construction and repair of utilities, providing a reasonable regulatory climate and expeditious permitting; designing new public infrastructure to allow for future utilities, encouraging joint use of utility corridors for utilities and recreation.
- **UT-10**: Determine utility infrastructure necessary for a given development concurrently with site plan entitlement.
- **UT-11**: Balance the need for provision of utilities at a reasonable cost with the need to protect the environment and natural resources.
- **UT-12**: Design, locate, and construct facilities to reasonably minimize adverse impacts to the environment and to protect environmentally sensitive areas. Take into account both individual and cumulative impacts. Minimize impacts through actions such as locating utility corridors in existing cleared areas and outside of sensitive areas such as wetlands and fish-bearing watercourses, using engineering techniques to minimize erosion on steep slopes and minimizing corridor widths.
- **UT-13**: Require undergrounding of all new utility distribution lines, except where undergrounding would cause greater environmental harm than alternatives or where the Washington Utilities and Transportation Commission tariff structure is not consistent with this policy. Consider new technologies such as wireless transmission as they become available.
- **UT-14**: Promote the undergrounding of existing utility lines by means such as requiring undergrounding of utility lines as a condition for redevelopment projects, undergrounding utility distribution lines or providing for future undergrounding as street projects occur, funding undergrounding and requiring service lines to be undergrounded when significant site improvements are made.
- **UT-15**: Require reasonable screening or architecturally compatible design of above-ground utility facilities. Promote high quality design of utility facilities through measures such as use of varied and interesting materials, color, artwork and superior landscape design.

- **UT-16**: Continue to utilize, protect, and sustain the Redmond well system to maximize the efficiency of the system as long as water quality is in accordance with or can be treated to meet State and federal drinking water regulations.
- **UT-17**: Protect groundwater sources by maintaining and monitoring a Wellhead Protection Program which guides land use decisions, development regulations, stormwater facility requirements, coordination with other agencies and other measures necessary to protect Redmond's well system.
- **UT-18**: Participate with the Cascade Water Alliance to acquire additional sources of supply for future needs.
- **UT-19**: Reduce average annual and peak day water use by participating in Cascade Water Alliance's conservation program.
- **UT-20**: Design water delivery and storage systems to provide efficient and reliable service, to balance short- and long-term costs, and to comply with State and federal regulations through methods including but not limited to: use of gravity feed whenever feasible, development of a looped system and standardization of transmission facilities sizing and materials.
- **UT-21**: Require new development to construct water system improvements necessary to serve the development and to provide a reliable integrated distribution system.
- **UT-22**: Maintain adequate storage facilities to meet equalizing and fire demand volume and emergency supply.
- **UT-23**: Pursue the creation of emergency interties with adjacent purveyors.
- **UT-24**: Prohibit the creation of new water systems within the City of Redmond to ensure that Redmond is the primary provider of water service. Facilitate the City being the sole provider by encouraging the connection to City water for those properties on existing private well systems.
- **UT-25**: Require connection to the City water system for all new development permitted by the City.
- **UT-26**: Require connection to the City water system for existing uses when redevelopment such as a short plat, subdivision or other significant land use action occurs to that property.

2.3.3. East King County Coordinated Water System Plan

East King County's Coordinated Water System Plan (1996) is another regional planning document that provides Redmond with guidelines for regional water use and planning. At a minimum, the City must meet the planning and design guidelines set forth in this document. Also presented in this Plan are the ways in which service area boundaries are determined, how boundary disputes are resolved, and the existing boundary for each of the utilities according to the East King County Regional Water Association.

Although changes have been made to Redmond's service area boundary since the last East King County Plan, all changes to Redmond's boundary have been consistent with guidelines set forth, and boundary dispute decisions made by, the East King County Regional Water Association. The East King County Plan has not yet been updated to reflect changes in service area boundaries and regional water supply and delivery that have resulted from the formation of Cascade Water Alliance (see Section 2.3.4). The individual water system plans of all purveyors in the CWSP area act as supplements to the adopted CWSP and new information regarding service area boundaries and regional water supply supersede those in the original plan.

2.3.4. Cascade Water Alliance Contracts and Planning Documents

The City of Redmond is a Member of Cascade Water Alliance. Cascade was formed by a group of eight water systems to jointly plan, develop and operate a regional water system for its members.

An Interlocal Contract among the now-seven (upon the departure of Covington Water District) members describes Cascade's purposes, funding and governance structure (see Section 2.5.6). Cascade's 2012 Transmission and Supply Plan describes Cascade's programs and water supply projects. Currently Cascade has entered into wholesale water supply agreements with two other regional water supply systems: Seattle Public Utilities (SPU) and Tacoma Public Utilities (TPU).

Under its agreements with SPU, Cascade has access to water supplies from SPU's Cedar River and Tolt River supply systems. The total quantity of water available on an average day basis is 33.3 million gallons per day (mgd) through year 2039. The contract extends through 2064 with a declining supply commitment beginning in 2039. This supply is currently delivered to several members of Cascade, including Redmond, through connections to SPU's regional transmission system. These amounts are increased during periods of peak demand up to 66.6 mgd.

Under its agreement with TPU, Cascade has access to water supplies from TPU's Green River supply system. The total quantity of water available on an average day basis is 10 mgd through 2026, and declining to four mgd by 2031. Based on recent data on Member demands, it appears the SPU supply, including the new Supplemental Water, is adequate to meet near-term needs for several years before the Tacoma supply will be needed.

In the long run, Cascade plans to develop one or more additional sources to meet its Members' needs, particularly once the SPU supply begins to decline under the contract described above. Cascade has purchased the former hydroelectric facility at Lake Tapps to become a regional water source. Facilities purchased include the lake, canals, power plant and water rights. Cascade's water rights related to this project were issued in 2010 by the Washington State Department of Ecology. Future development of Lake Tapps for municipal supply will require a variety of permitting actions and construction of a water treatment plant and transmission pipeline.

Cascade is currently working with SPU and TPU to negotiate water blocks to provide demand through the late 2060's and postpone development of Lake Tapps. If extended water blocks are not in place, construction of Lake Tapps would need to begin in 2033.

Under the Cascade Interlocal Contract, Redmond retains ownership and control of its own groundwater sources. Cascade commits to meeting Redmond's water supply needs exceeding the capacity of the Redmond's local sources. In the event Cascade's supplies are not fully sufficient at any given time to meet the full need of all its members, the Interlocal Contract specifies that shortages will be shared among all its members.

Cascade also provides water conservation services to Redmond and other Cascade members. Activities covered by Cascade are described in the 2019-2022 Regional Water Efficiency Program.

2.3.5. City of Bellevue Water Comprehensive Plan

Bellevue is one of Redmond's adjacent purveyors with shared joint-use facilities, serving the Overlake and Viewpoint neighborhoods in the southern third of Redmond's retail service area. Bellevue's 2016 Water Comprehensive Plan is important to Redmond because of the joint ownership of a 6.0-MG storage reservoir and pump station within Bellevue's water service area that provides water to Bellevue and Redmond customers. Redmond is working with Bellevue on possibly constructing a new shared reservoir and pump station in the Overlake area. Redmond and Bellevue have interlocal agreements to address maintenance and operation of jointly-owned facilities and water supply requirements (see Section 2.6). Sections of Bellevue's plan that are of interest to Redmond include the storage analysis, operations and maintenance, and any capital improvement projects that pertain to jointly owned facilities.

2.3.6. City of Kirkland Comprehensive Water System Plan

Kirkland and Redmond share a service area boundary, and the two cities have joint ownership of supply and storage facilities that serve the Rose Hill areas of Redmond and Kirkland. The Rose Hill Water District was assumed in 1994 and portions of the district were incorporated into the water service areas of Kirkland, Bellevue and Redmond. This joint ownership means that Redmond has an interest in the sections of Kirkland's Water Comprehensive Plan that pertain to the shared supply, storage, and distribution facilities that serve the Rose Hill service area. Redmond and Kirkland have interlocal agreements to address maintenance and operation of jointly-owned facilities and water supply requirements (see Section 2.6).

2.3.7. Sammamish Plateau Water and Sewer District Water Comprehensive Plan

Redmond and Sammamish Plateau Water and Sewer District have an interlocal agreement under which Redmond provides access to the District for water from Cascade Water Alliance, through an intertie. The District's Water Comprehensive Plan documents this supply arrangement. The District's service area (Cascade View Zone) abuts a portion of Redmond's Novelty Hill Service Area, and this is also reflected in the District's Water Comprehensive Plan.

2.3.8. King County Reclaimed Water Planning Efforts

An element of King County's program is the capacity for production of reclaimed water at the Brightwater Treatment Plant located in Snohomish County. A "backbone" distribution system has been developed to convey reclaimed water to the area south of the Brightwater Treatment Plant, including portions of the Sammamish River Valley north of Lake Sammamish. Existing reclaimed water users near the City of Redmond include the Willows Run Golf Course and the 60 Acres Soccer Complex, where this resource is used for irrigation and the York Fill Station. These locations are located outside of Redmond's CARA.

Redmond Municipal Code 13.07.085.A.2 and Redmond Zoning Code 21.64.050.C.1.p and 21.64.050.C.2.b limits the use of reclaimed water within Redmond's critical aquifer recharge area (CARA) to only uses that discharge to the sanitary sewer. Redmond and King County have worked collaboratively on protecting the City's shallow alluvial aquifer through a series of Memorandums of Understanding (MOU). The MOUs restrict certain uses with the Redmond's CARA and King County has agreed to honor those restrictions within the portions of Redmond's CARA that extends into King County. Additionally, King County and Cascade Water Alliance

entered into an MOU that applies to service areas of Cascade Water Alliance members. The MOUs are listed below:

- Agreement to Coordinate Reclaimed Water between King County and Cascade Water Alliance. Adopted January 1, 2019.
- Memorandum of Understanding between King County and Redmond regarding Marymoor Park. Adopted September 25, 2018.
- 2017 Memorandum of Understanding between King County and The City of Redmond Regarding Reclaimed Water regarding York Reclaimed Water Truck Fill Station. Amended July 29, 2021.

The composition of Redmond's unconfined aquifer yields high infiltration rates, low organic content, and shallow depth to groundwater. Redmond's alluvial aquifer has consistently been identified as highly susceptible to surficial contamination. The Redmond-Bear Creek Valley Groundwater Management Plan (Redmond-Bear Creek Ground Water Advisory Committee 1999) identified the vast majority of Redmond's alluvial aquifer as highly susceptible to surficial contamination due to surficial infiltration potential of the soils. The 1997 Source Water Assessment designated four out of the five City operated drinking water supply wells as highly vulnerable to surface contamination due to the lack of a confining layer in the aquifer that would prevent the migration of surface contamination, shallow supply well screens, and type and intensity of land use in proximity to the wells. For this reason, the City has consistently applied caution when evaluating and regulating risk to the water quality of the drinking water aquifer.

The limitations put on reclaimed water use within the City's CARA were adopted by City Council as recently as 2019 because there is insufficient data to determine that Brightwater reclaimed water effluent does not pose health risks to use within a shallow, unconfined, alluvial aquifer system. From the limited 2019 sampling in the reclaimed water from the Brightwater York Pump Station, 20 polybrominated diphenyl ethers chemicals, 10 Per- and Polyfluoroalkyl Substances, and 20 pharmaceutical and personal care product chemicals were detected. The Growth Management Act requires that the City of Redmond designate and protect its CARA. The City obtains approximately 40% of its drinking water from City groundwater wells within the CARA. The City has put additional protections in place within the CARA to protect the City's drinking water source from potential degradation caused by reclaimed water use since there is insufficient data to determine health risk of reclaimed water use over a vulnerable aquifer. Data must conclusively show there is no risk of contamination from the use of reclaimed water on a shallow, unconfined, alluvial aquifer system, before the City will remove limitations on reclaimed water use within the CARA and risk contamination of its drinking water supply.

The relation of these County reclaimed water planning efforts to the City's evaluation of reclaimed water opportunities is addressed in Section 7.4.

2.4. Retail Service Area Characteristics

This section characterizes the City's retail water service area. The City's retail service area includes both areas where Redmond currently provides water service, and areas where the City intends to make service available within the 20 year planning period covered in this Plan.

2.4.1. Retail Service Area Boundaries

Redmond's existing city limits, Redmond's planned retail service area, and King County's urban growth area boundaries are depicted along with adjacent water purveyors in Figure 2-1. As

shown in the figure, the City's retail service area generally conforms to the city limits, with the exception of the Novelty Hill service area northeast of the City along Novelty Hill Road, and the areas served through the assumption of Rose Hill Water District.

The City does not anticipate any major changes to its retail service area in the immediate future, although the service area may be expanded to provide service to areas annexed into the City in the future (see Section 2.3.1). It should also be noted that the Redmond water system does provide water service outside its official service area to a small number of isolated customers along NE Redmond Road (see Figure 2-1). These customers were connected to the original pipeline from Seidel Creek known as the "Country Route" pipeline. Eventually the City would like to abandon this facility east of Farrel McWhirter Farm Park. At this time the City plans to continue maintaining the system and providing water to existing customers. The City is discussing this area with Union Hill Water Association and Woodinville Water District to seek an appropriate solution that avoids unreasonably costly infrastructure improvements. The City does not plan to provide any additional services from this line in the future; therefore, this area is not shown as being within the official retail service area boundaries. No meter/service upgrades or new services will be approved for this area.

Small service area changes have occurred at the northwest corner of the service area (area transferred to Kirkland). Customers in the northeast corner of the service area (area outside the City's Urban Growth Area) have received water meters and are fully integrated into the City's retail service area.

The City serves several areas outside the city limits, including: Marymoor Park, 60 Acres Park, portions of the Rose Hill water service area, and the Novelty Hill Urban Planned Developments in unincorporated King County. For the portions of the City's system in unincorporated King County, the City has franchise agreements with the County. Two franchise agreements were adopted in 2022, replacing prior franchise agreements, one for the Novelty Hill utility and one for the City utility. These agreements authorize use of County right-of-way over large areas of unincorporated King County near the City of Redmond, but do not represent a commitment to serve water to customers within all of those areas.

The City's service area has changed over the past few years due to annexations and service to areas within the UGA. The service area is no longer consistent with that shown in the East King County Coordinated Water System Plan. The service area boundary shown in the East King County Plan should be changed when it is next amended to be consistent with this Plan.

2.4.2. Geography, Zoning, and Land Use

The Redmond Comprehensive Plan and the Redmond Zoning Code designate neighborhood-planning areas around the City for the purpose of describing the intended land use and local development characteristics.

Figure 2-4 and Figure 2-5 show land use and zoning designations in Redmond and adjacent unincorporated areas of King County. Detailed information regarding zoning and land use for these areas is available in the Redmond Comprehensive Plan and the Redmond Zoning Code.

Policies in the Downtown/Overlake Urban Center are intended to increase densities and direct the majority of the City's housing and employment growth to these two areas. This has been the case since the prior plan and has the potential to impact water demand and infrastructure needs

in these areas. Significant growth is also proposed in the Marymoor Village area that will be served by a new light rail station in the future.

2.5. Service Area Policies and Conditions of Service

This section provides a summary of selected provisions from Title 13 of the Redmond Municipal Code (RMC) that affect the City's water system, and City policies regarding annexation and associated water service extension.

2.5.1. Wholesale Water

The City has no current plans to provide water to other water systems on a wholesale supply basis. However, the City may be willing to participate in regionally coordinated water supply efforts.

The City currently holds a wheeling agreement with Sammamish Plateau Water and Sewer District. This agreement allows the District to access Cascade Water Alliance's water supply via Redmond's transmission system.

2.5.2. Annexation

As described in Section 2.3.2, the City's Comprehensive Plan identifies areas of potential annexation and uses land use policies and zoning to encourage the concentration of growth in these areas. These policies include the extension of utility service to areas within the UGA where growth is anticipated to occur. The City may provide water service to areas or properties that have not been annexed, either in anticipation of future annexation, or otherwise on a case by case basis.

2.5.3. Direct Connections and Satellite Systems

For any new connections to the City's water system, the City requires that a service meter be installed and that an installation charge be paid to the City (RMC Chapter 13.08). There are currently no satellite systems served by Redmond and the City has no plans for adding or managing any satellite systems in the future.

2.5.4. Extension

As described in Section 2.4.1, the City's retail service area includes both areas currently served and areas where extension of the water system is anticipated within the 20 year planning period covered by this Plan. Policies related to extension of water service are included in RMC Chapter 13.11. Other key policies are summarized below:

- Subdivision and Short Subdivision Regulations – provide criteria, regulations and standards to govern the subdividing of land within the City, and to provide for water service and other public requirements (RZC 21.74)
- Review and Approval Criteria – each proposed subdivision or short subdivision shall be reviewed to ensure it will be adequately served with City approved water and other utilities appropriate to the nature of the subdivision. No final plat or short subdivision shall be approved unless it contains a dedication to the public of all common improvements,

including water supply systems which were a condition of approval, and that city approved water facilities will be available to each lot created by the division of land (RZC 21.74.030)

- Easements – public easements for the construction and maintenance of utilities and public facilities shall be granted to provide and maintain adequate utility service to each lot and adjacent lands (RZC 21.74.020(C)(1-5)).
- Water Supply – All lots shall be served by a water system approved by the City of Redmond. Any common water system serving more than one lot shall be provided by the applicant and dedicated to the appropriate water purveyor. Such water supply systems shall be designed and constructed according to all applicable provisions of the Development Guide, the standards and specifications of the water purveyor and the applicable rules and regulations of the state (RZC 21.74.020(D)).
- Water Standards – All City water facilities shall be designed in compliance with the "Design Requirements Water and Sewer System Extensions" document, and shall be constructed in compliance with the standards and specifications available from the Utility Division of the Public Works Department (RZC Appendix 3).
- Adequate Public Facilities and Services Required – requires that public facilities and services are adequate to support development or will be provided in a timely manner consistent with the Public Facilities and Services goal of the Growth Management Act (RZC 21.17.010).
- General Requirements – all new development proposals requiring City approval shall be adequately served by water supply prior to the time of occupancy, recording, or other land use approval (RZC 21.17.010(B)).
- Utility Availability Certificate – prior to approval, applicant is required to provide a utility availability certificate from the Public Works Department. If a certificate was approved as part of a subdivision or site design process, a new certificate will not be required for a subsequent building or development permit, unless changes result in water impacts not considered when the proposal was first approved (RZC 10.17.010).
- Adequate Water Supply – All uses shall be served by an adequate water supply system. The applicant must demonstrate that the proposed development can be connected to the City's water system or another system approved by the City, that the water system can provide sufficient flows to serve the proposed uses and fire flows, and that the system has sufficient storage capacity to serve the proposed uses and fire flows. The applicant may receive conditional approval and/or be required to make improvements to the system prior to approval. Before occupancy or recording, a final inspection will be conducted to ensure that the system will adequately serve the proposed building or use (RZC 21.17.010(D))
- Adequate Fire Protection – all new developments shall be served by adequate fire protection (RZC 21.17.010(G)).
- Construction Standards, Specifications, and Drawings – the Public Works Department shall prepare and approve design standards and construction specifications for water systems (RZC 21.17.010(H)).
- Extensions Outside City Limits. Applicants for extensions outside of the city limits must complete and submit a utility extension agreement to be approved by the City. An applicant must agree the development to be served will meet the requirements of the City's comprehensive plan, zoning code and building regulations; and must pay all costs of extending service. In addition extension outside City Limits cannot be granted without approval from the Redmond City Council (RMC 13.36).

In some cases, property owners who are served by an extension are required to pay an "equitable share of the costs." These charges are in addition to any other connection costs required by the City's Municipal Code.

In cases where the City already provides service to customers in unincorporated King County, fire service requirements reflect the standards that were in effect at the time service was granted or substantial system upgrades were made. In cases where the City agrees to provide service to new customers outside City Limits in the future, the City will consider the proposed fire flow provisions and the City Council will determine whether those provisions are suitable for granting service. Typically if the area to be served lies within the City's Urban Growth Area, the City would require that City fire-flow requirements be met.

2.5.5. Customer Inquiries

The City manages its customer inquiries through the Q-Alert system. Customers with water-related inquiries should call the numbers listed in Table 2-1, based on the particular issue or concern.

Table 2-1. Contacts for Customer Inquiries

Topic	Telephone Number
Utility Billing	(425) 556-2152
Water System Repair and Operation	(425) 556-2800
Development Services	(425) 556-2876
Water Quality	(425) 556-2847

The Maintenance and Operations Center (MOC) uses the facilities maintenance and management program Lucity to do most record keeping, which includes work orders that originate from customer inquiries. Records of customer inquiries and requests are kept on file at the MOC. These records include the customer name and address, date, nature of the call, and final disposition.

Utility Billing (a division of the Finance Department) receives two major types of inquiries: either a problem with a service meter, or a question or concern about a customer's water bill. Any problem with a meter is written up in a service order and given to the MOC to investigate and correct. Once the problem has been addressed, the service order is returned to Utility Billing and a comment is added to the customer's account. Issues with a customer's bill are typically handled on a case-by-case basis and can be resolved in a timely manner.

2.6. Interlocal Agreements

The City shares boundaries and water service facilities with a number of neighboring water purveyors. Table 2-2 lists interlocal agreements that are relevant to either the City's retail service area or its water supply. Additional details of selected key agreements with neighboring utilities are described below. Copies of the interlocal agreements described below are provided in Appendix D.

2.6.1. Northeast Sammamish Water and Sewer District

Redmond's southeast service area boundary is adjacent to Northeast Sammamish Sewer and Water District. The City shares a metered intertie with the district for emergency purposes. The intertie is located at 187th Avenue NE and NE 55th Street and links pressure zones that are at a 300-foot hydraulic gradient for both the City and the district.

2.6.2. Woodinville Water District

Woodinville's service area borders Redmond's northern retail service area boundary for both the in-City and Novelty Hill service areas. The City and Woodinville Water District have an interlocal agreement that describes how water service will be managed along their common boundaries. There have been many addenda to this agreement, addressing individual properties.

2.6.3. Union Hill Water Association

Union Hill borders Redmond's service area boundary and lies between the Well Service Area and the Novelty Hill Service Area. Novelty Hill is adjacent to Union Hill's eastern border. There are three existing emergency interties between Union Hill and the City's Novelty Hill water system.

Redmond previously had an interlocal agreement with Union Hill as a wholesale provider. This agreement expired in 2006. The existing interties at 95th Street are now used for emergency purposes only, which is governed by an interlocal agreement.

2.6.4. Sammamish Plateau Water

The Sammamish Plateau Water Comprehensive Plan was updated in 2018. Redmond's Novelty Hill area is immediately north of Sammamish Plateau Water and Sewer District's Cascade View Zone. A small portion of Redmond's southeastern border is contiguous with Sammamish Plateau's future service area boundary in the Plateau zone. Redmond and the District have an interlocal agreement under which Redmond provides the District access to water supply from Cascade Water Alliance via an intertie with the Redmond system.

Table 2-2. Interlocal Agreements

Agreement	Parties to Agreement	Date Issued or Amended	Description
Agreement for Water System Interties (Redmond Ridge)	Union Hill Water Association	2001	Provides interties between Union Hill Water Association and Redmond for emergency purposes.
Interlocal Agreement and Amendments	Woodinville Water District	Various	Interlocal Agreement designating the common service boundary between Woodinville Water District and Redmond (with multiple addenda since 1988.)
Interlocal Contract	Cascade Water Alliance	2002	Contract among Cascade members to establish the Cascade Water Alliance and facilitate its purposes
Agreement for Water System Intertie	Sammamish Plateau Water	2005	Provides an intertie between the Sammamish Plateau Water and Redmond to allow the District access to the Cascade Water Alliance water supply.
Agreement for Water Distribution	City of Bellevue	1990, 2005, 2022	Provides for responsibilities and obligations of Bellevue and Redmond related to jointly-owned water system facilities (distribution/ transmission mains).
Agreement and Amendment to Interlocal Operation and Maintenance Agreement	City of Kirkland and City of Bellevue	1997, 2005	Assumption Agreement where Redmond assumed Rose Hill Water District, stating that water will be supplied by Cascade Water Alliance.

Agreement	Parties to Agreement	Date Issued or Amended	Description
Interlocal Operation and Maintenance Agreement	City of Kirkland and City of Bellevue	1997	Provides for responsibilities and obligations of Bellevue, Kirkland and Redmond for the operation and maintenance of jointly-owned water supply facilities.
Agreement for Water System Intertie (95th Street)	Union Hill Water Association	2007	Provides intertie between Union Hill Water Association and Redmond for emergency purposes.
Agreement for Water System Intertie	Northeast Sammamish Sewer and Water District	1996	Provides intertie between Northeast Sammamish Sewer and Water District and Redmond for emergency purposes.

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Chapter 3: Water System Description

City of Redmond 2023 Water System Plan DRAFT

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3. Water System Description

This section provides a general overview of Redmond's water system, including its history, a description of adjacent purveyors, characteristics of the water service area, interlocal agreements, and policies related to water service. In addition, this section includes a description of the City's water facilities and infrastructure.

3.1. Systems and Pressure Zones

The City of Redmond water system currently supplies its water customers via four distinct but interrelated areas: the Well Service Area, Rose Hill Service Area, Overlake/Viewpoint Service Area, and Novelty Hill Service Area. Figure 3-1 displays the pressure zones and key water system facilities for the City's retail service area. Figure 3-2 through Figure 3-5 show hydraulic profiles of each of the service areas that illustrate operation of the water system.

Service elevations within the Redmond water system range from approximately 30 to 500 feet in and adjacent to the City; and from 320 to 610 feet in the Novelty Hill Service Area. To provide water under appropriate service pressures to customers regardless of location, each of Redmond's service areas is divided into a number of distinct pressure zones. These pressure zones and their boundaries have been established in accordance with area topography and service elevations, natural and physical barriers, and the limits of the City's water service area boundaries. Topographic considerations are significant because the City seeks to maintain operating pressures throughout the system between 30 and 80 psi (40 and 80 psi for new service areas). The nominal hydraulic grade lines (HGLs) and range of service elevations for each of Redmond's various service areas and pressure zones are summarized in Table 3-1.

Table 3-1. Pressure Zones

Pressure Zone	Operating Hydraulic Grade Line	Minimum Service Elevation (ft)	Maximum Service Elevation (ft)	Minimum Static Service Pressure (psi)	Maximum Static Service Pressure (psi)[1]
Well Service Area					
238	239	30	152	31	86
285	283	103	133	40	55
300	379	85	171	55	125
315	314	120	224	39	84
335	335	47	210	54	124
350	351	66	266	36	121
390	391	32	266	52	153
470	470	60	400	25	124
565	636	314	423	54	103
Rose Hill Service Area					
285	286	28	182	44	110
335	335	47	210	54	124
395	376	116	312	28	111
425	426	76	338	37	148
545	545	148	464	33	170
650	711	395	501	91	136
Overlake/Viewpoint Service Area					
335	333	34	243	38	127
415	416	160	321	41	110
435	435	228	275	63	84
465	465	277	328	60	82
520	520	150	396	41	116
Novelty Hill Service Area					
625	625	366	506	51	111
670	670	414	564	39	103
730	730	505	607	48	92

[1] Individual pressure-reducing valves are required for customers in areas with static pressures greater than 80 psi.

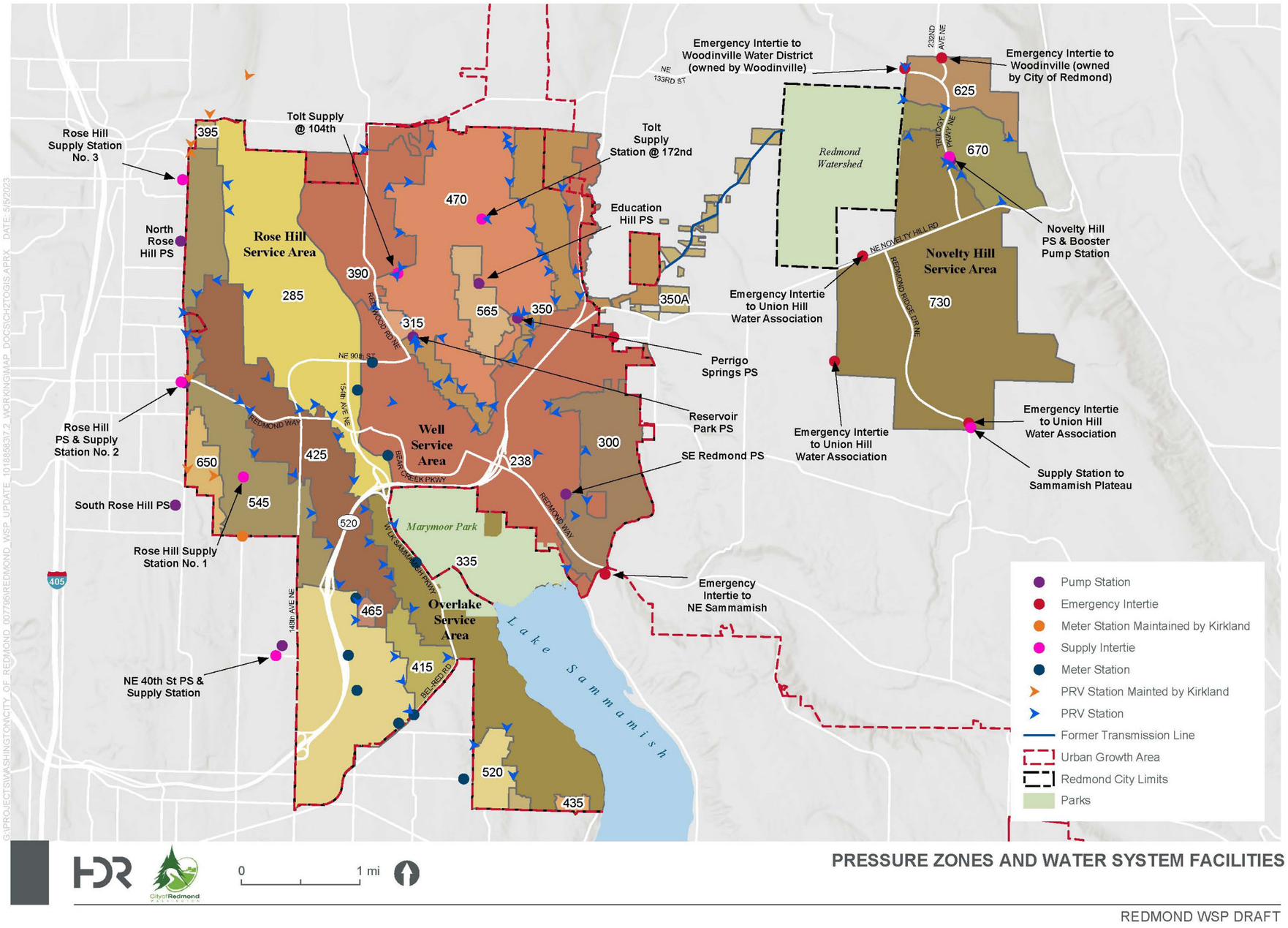

Figure 3-1. Pressure Zones and Water System Facilities

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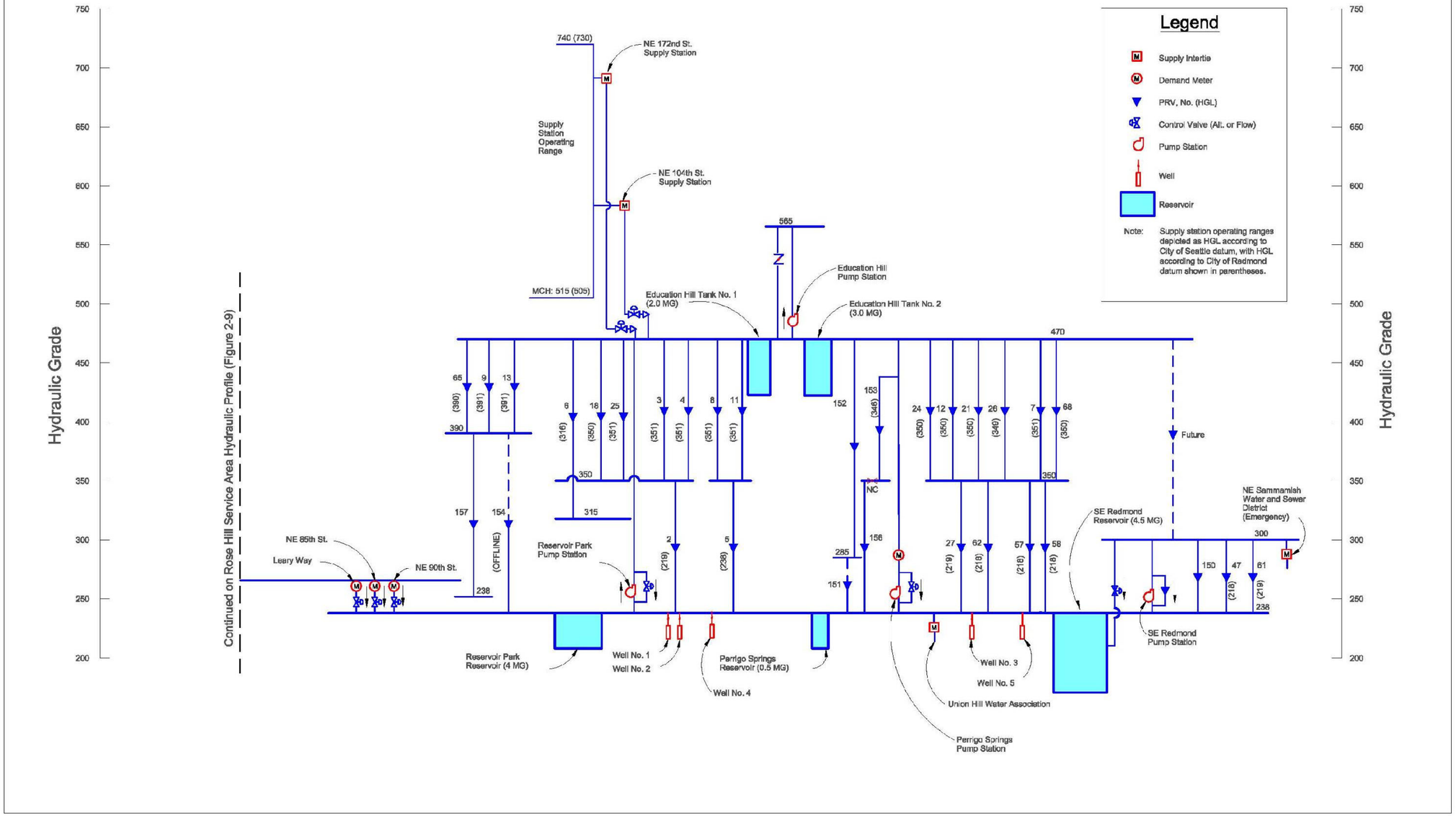

Figure 3-2. Well Service Area Hydraulic Profile

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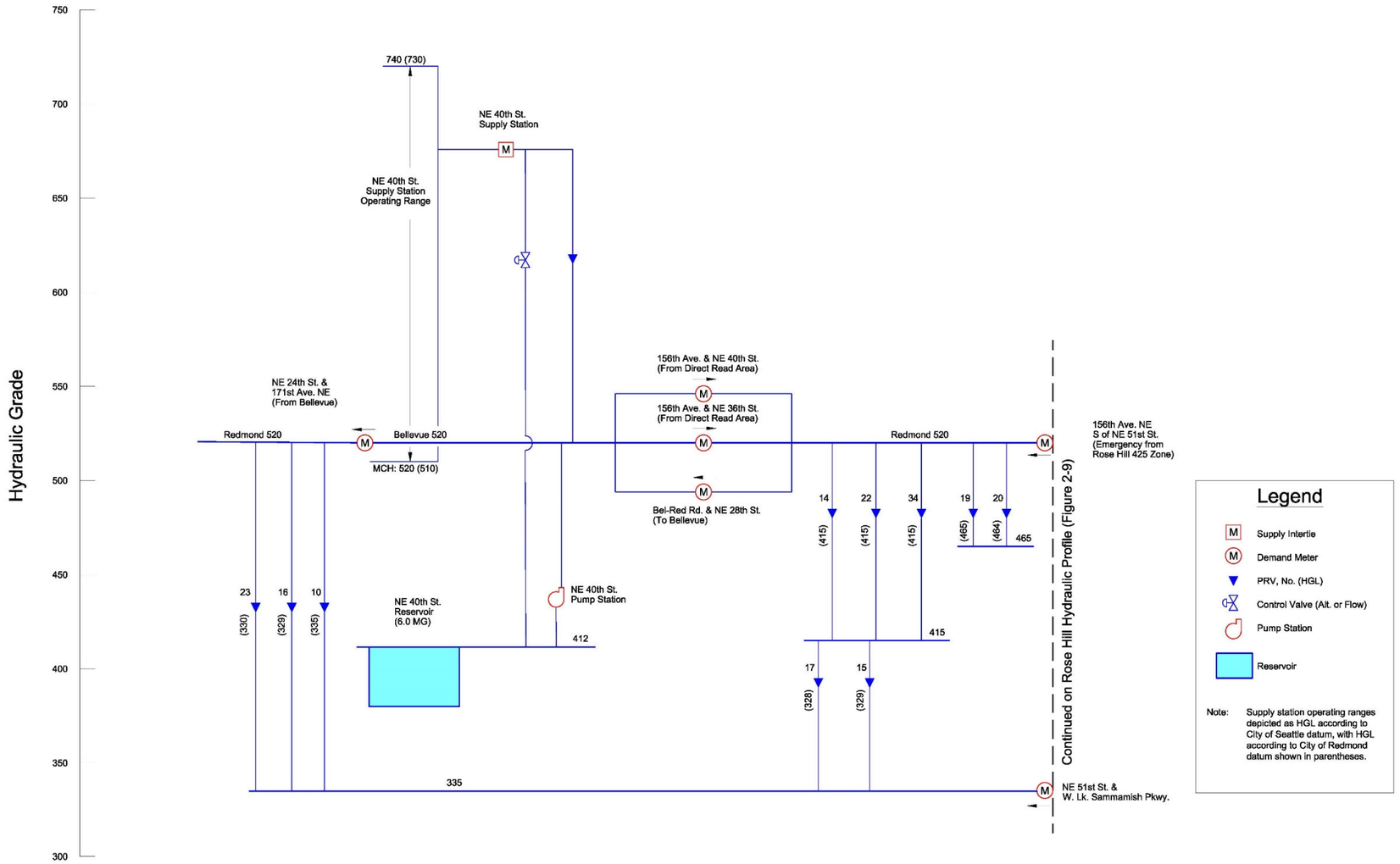

Figure 3-3. Overlake/Viewpoint Service Area Hydraulic Profile

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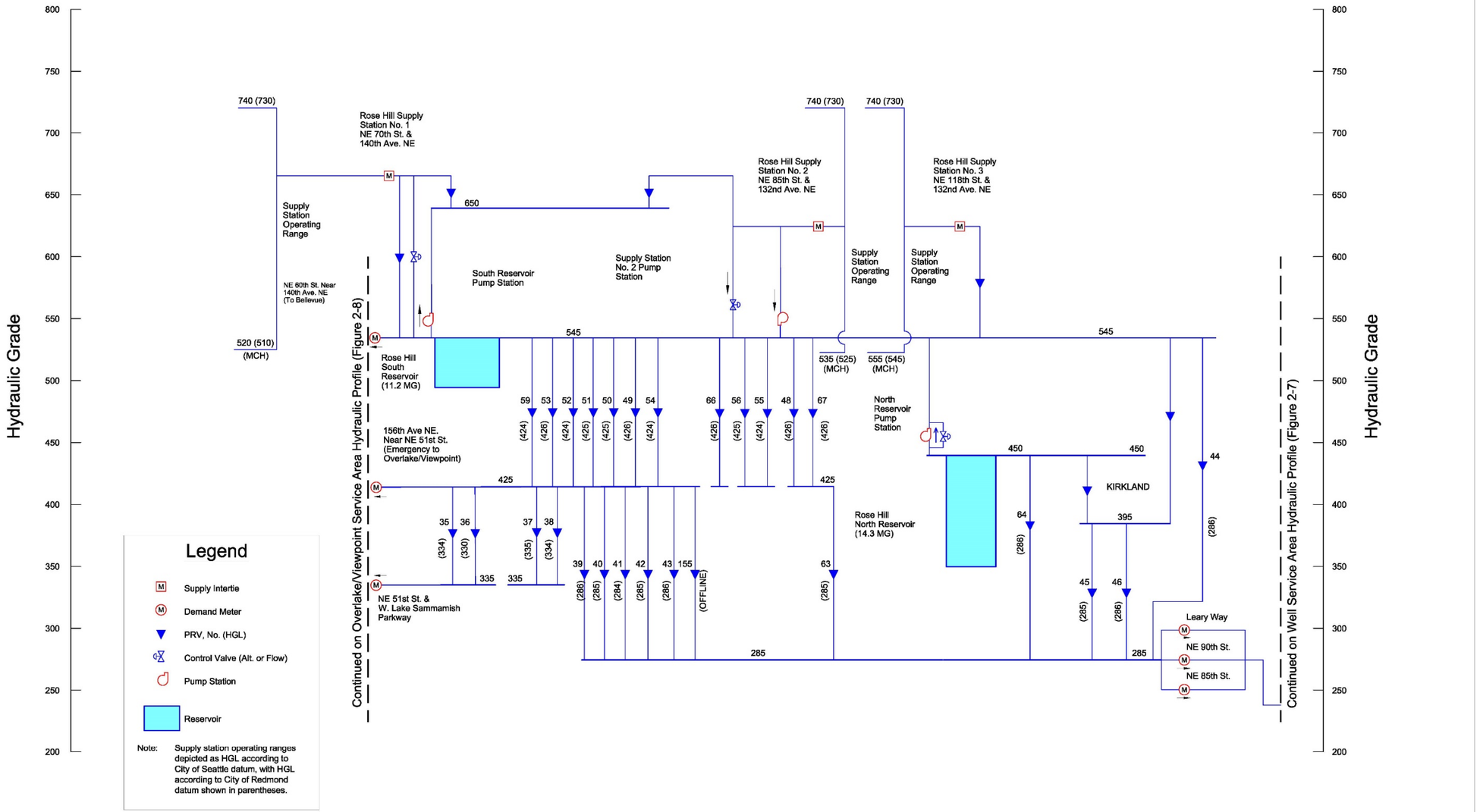

Figure 3-4. Rose Hill Service Area Hydraulic Profile

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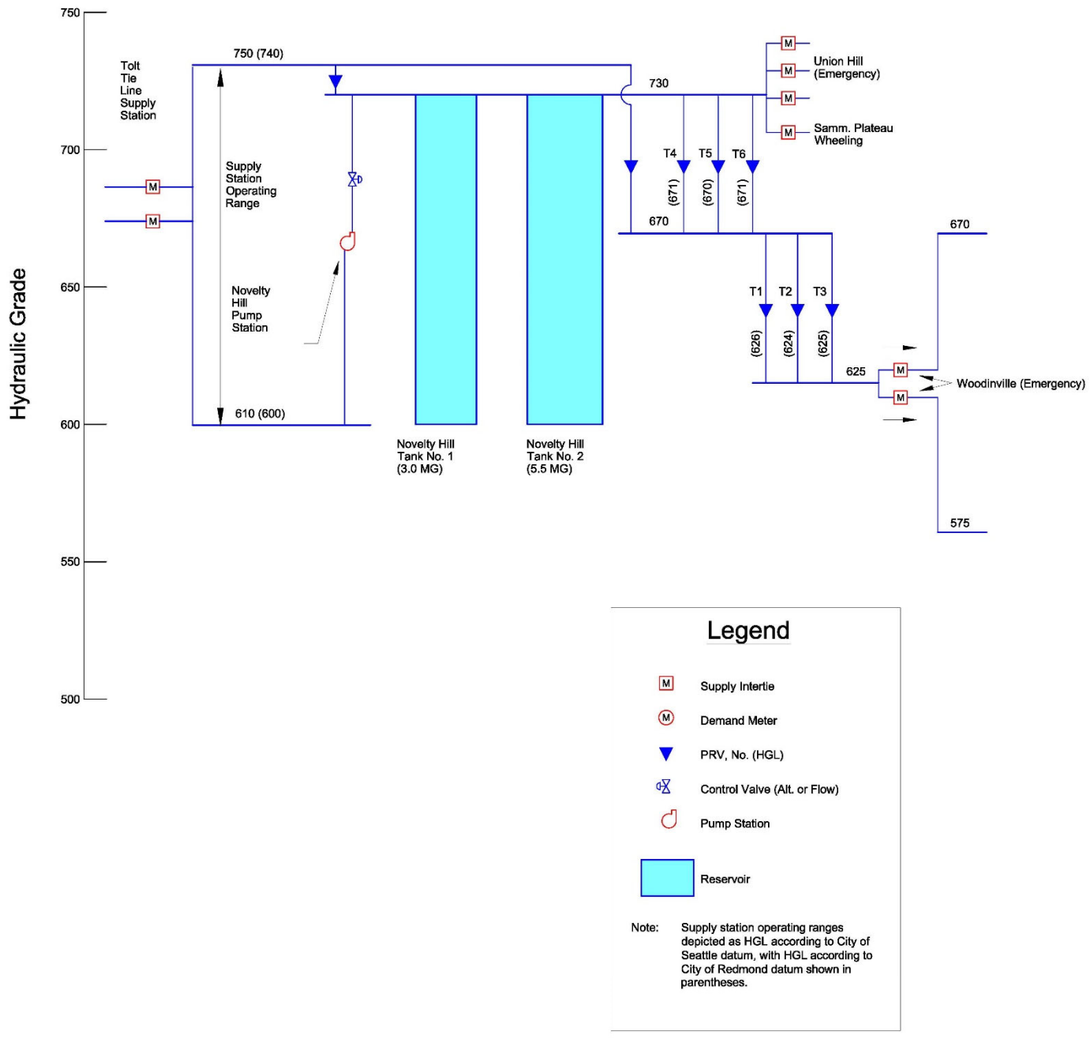

Figure 3-5. Novelty Hill Service Area Hydraulic Profile

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3.1.1. Well Service Area

The Well Service Area generally includes those portions of the City's water system east of the Sammamish River and west of Bear and Evans Creeks as shown in Table 2-3 and includes the following neighborhoods:

1. Bear Creek
2. Downtown
3. Education Hill
4. North Redmond
5. Sammamish Valley
6. Southeast Redmond

Supply for the Well Service Area is provided by the City's groundwater wells and two connections to Seattle Tolt Pipeline No. 2, one along NE 104th Street and the other on NE 172nd Street. In addition, three connections with the Rose Hill Service Area can be used to supplement the supplies within the Well Service Area.

The Well Service Area is divided into nine pressure zones with nominal static hydraulic grade line elevations of 238, 285, 300, 315, 335, 350, 390, 470, and 565. The following sections summarize the major pressure zones and water system facilities within Redmond's well service area. Information regarding the major water system facilities including source, storage, and transmission installations are also tabulated toward the end of this section.

238 Pressure Zone

The City's groundwater supply wells, Well Nos. 1, 2, 3, 4, and 5, supply the 238 pressure zone, as shown in Figure 2-3.

Well No. 4 was rebuilt on the City Campus in 2003 to include an upgraded caustic soda storage and delivery system, a sodium fluoride dry chemical mixing unit, and on-site generation of low strength sodium hypochlorite.

In that same timeframe, Well Nos. 3 and 5 were also upgraded, with all new well house structures, pumps, mechanical and electrical equipment, piping, and chemical-feed systems. Each facility includes both well and booster pumps, with an intermediate clearwell to establish appropriate chlorine contact time before water enters the distribution system. Caustic soda addition for pH adjustment was replaced with a packed tower for stripping carbon dioxide from the groundwater. In a similar manner to Well No. 4, on-site generation of sodium hypochlorite and a dry chemical mix system for sodium fluoride were added. The Well No. 5 upgrade was completed in 2005 and the Well No. 3 upgrade was completed in 2008.

In 2009 the City completed upgrading and refurbishing Well Nos. 1 & 2 to match the upgrades of Well Nos. 3 and 5. The well houses (both located in Anderson Park) were rebuilt and designed to pump untreated water to a new treatment facility located approximately 400 feet north of the Park. The new treatment facility provides the same treatment scheme as the upgraded Well Nos. 3 and 5, before booster pumping treated water into the distribution system.

The chlorination systems for all wells were upgraded in 2021/2022, with the on-site sodium hypochlorite generation systems replaced with newer systems that are more readily maintained with available replacement parts.

The 238 pressure zone can also receive water from the Rose Hill Service Area through three metered motorized butterfly flow control stations connecting this zone to the 285 pressure zone along the Sammamish River: one at NE 90th Street, one at NE 85th Street, and one at Leary Way NE. Water from the 300, 350, 390, and 470 pressure zones can also be delivered to the 238 pressure zone through a number of PRVs.

Storage for the 238 pressure zone is provided in three existing tanks: a 4.0-MG prestressed-concrete reservoir at the Reservoir Park site, a 0.5-MG steel reservoir at the Perrigo Springs site, and the 4.5-MG Southeast Redmond Reservoir.

The 238 pressure zone supplies the 300 pressure zone through the Southeast Redmond Booster Pump Station, and the 470 pressure zone through the Reservoir Park and Perrigo Springs Booster Pump Stations.

285 Pressure Zone

The 285 pressure zone was created when a portion of the 350 zone experienced pressures that exceeded 100psi on the lower east side of Education Hill. The high pressures were reduced by splitting the 350 zone into two parts via closing a valve and adjusting one of the PRVs feeding the area from the 470 zone. Closing the valve reduced the supply into each of the zones from two sources to one. This zone is not equipped with a storage tank, and HGL in the zone is maintained by the associated PRV. This zone also has the capability to augment pressures and supply in the 238 pressure zone below through a PRV.

300 Pressure Zone

The 300 pressure zone serves the higher elevation areas of Southeast Redmond through the Southeast Redmond Booster Pump Station. The 300 pressure zone does not include a storage tank. The 300 zone, originally supplied only through the southeast Redmond Booster Pump Station, is supplied by the southeast Redmond transmission main. This pump station can serve as the zone's source if the transmission main is interrupted.

335, 350, and 390 Pressure Zones

The 335, 350, and 390 pressure zones serve the lower elevations of Education Hill and are all served from the 470 pressure zone above through PRVs. None of these zones are equipped with storage tanks, and the HGLs in each of these zones are maintained by the associated PRVs. Most of these zones also have the capability to augment pressures and supply in the 238 pressure zone below through a number of additional PRV installations.

470 Pressure Zone

The 470 pressure zone serves the intermediate elevation of Education Hill and is supplied from the 238 pressure zone via the Reservoir Park and Perrigo Springs Pump Stations. Storage in the 470 pressure zone is provided by the 2.0-MG steel Education Hill Reservoir No. 1 and the 3.0-MG steel Education Hill Reservoir No. 2.

Additional supply to the 470 pressure zone is available from two metered supply connections to Seattle's Tolt Pipeline No. 2, located along NE 104th Street and NE 172nd Street. The supply connections are equipped with flow- and pressure-reducing control valves, which maintain pressures and supply flow rates appropriate for the 470 pressure zone. The guaranteed 531-

foot HGL of Seattle's Tolt Pipeline No. 2 (525 feet on City of Seattle datum) provides sufficient pressure to fill the City's Education Hill reservoirs.

The 470 pressure zone supplies the 238, 335, 350, and 390 pressure zones through a number of PRVs and supplies the 565 pressure zone via the Education Hill Pump Station.

565 Pressure Zone

The 565 pressure zone, which serves the higher elevations on Education Hill, is supplied from the 470 pressure zone below by the Education Hill Pump Station. The zone, which is not equipped with a tank, can also be supplied directly from the 470 pressure zone at a reduced pressure through a check valve located along NE 104th Street. Fire flow to the 565 pressure zone is limited to 1,500 gpm.

3.1.2. Rose Hill Service Area

In 1994 the Cities of Bellevue, Kirkland and Redmond each assumed portions of the former Rose Hill Water District water system. The distribution system in this area serves sizable areas of all three cities and each municipality acquired ownership of those portions of the system within its own water service area and corporate boundaries. The system, which remains hydraulically connected, includes a number of jointly owned and operated supply, storage, and pumping facilities.

The Rose Hill Service Area, as shown in Figure 2-3, provides water service generally to those areas of Redmond east of NE 132nd Avenue, west of the Sammamish River, and north of NE 51st Street, along the western slopes of the Sammamish River Valley, including the following Redmond neighborhoods:

1. Grass Lawn
2. Sammamish Valley
3. Willows
4. A small area north of NE 124th, adjacent to the Willows neighborhood, in a future annexation area for the City of Kirkland

Water supply to the Rose Hill Service Area is provided by three metered supply connections to the Tolt Eastside Supply Line: Supply Station No. 1, located at NE 70th Street and 140th Avenue NE; Supply Station No. 2, located at NE 85th Street and 132nd Avenue NE; and Supply Station No. 3, located at NE 116th Street and 132nd Avenue NE. Supply Station No. 1 is jointly owned by the cities of Bellevue, Kirkland and Redmond, while Kirkland and Redmond alone share ownership of Supply Station Nos. 2 and 3. These supply stations are described in more detail later in this section.

The Redmond portion of the Rose Hill Service Area is divided into several pressure zones (the 650, 545, 425, 395, 335, and 285 zones). The following sections summarize the major pressure zones and water system facilities within the Redmond Rose Hill service area. Information regarding Redmond's major water system facilities, including source, storage, and transmission installations, are also tabulated toward the end of this section.

650 Pressure Zone

The 650 pressure zone is supplied from metered connections to the TESSL at Supply Station Nos. 1 and 2. The supply stations serve the 650 pressure zone through PRVs, which maintain pressures and supply flow rates appropriate for the pressure zone.

The 650 pressure zone can also receive water from the 545 pressure zone through the 650 Zone Pump Station when adequate supply flows or pressures are not otherwise available from Supply Station Nos. 1 and 2. The 650 pressure zone is not equipped with a storage reservoir, and the HGL in the zone is maintained by the South Reservoir Pump Station and/or the PRVs associated with the supply stations.

545 Pressure Zone

The 545 pressure zone is supplied from the TESSL via Supply Station Nos. 1, 2 and 3. These metered supply stations each serve the 545 pressure zone through flow-and pressure-reducing control valves, which maintain pressures and supply flow rates appropriate for the pressure zone.

Water storage for the 545 pressure zone is provided by the Bellevue/ Kirkland/Redmond 11.2-MG steel South Reservoir located at 132nd Avenue NE near NE 65th Street. Water from the South Reservoir and the 545 pressure zone can also be delivered to the 650 pressure zone through the South Reservoir Pump Station.

The 545 pressure zone supplies the Kirkland/Redmond 14.3-MG steel North Reservoir at a 450-foot HGL through an altitude valve. The North Reservoir serves Kirkland's 450 pressure zone directly, and also serves the 545 pressure zone through the North Reservoir Pump Station, which allows water to be transferred from the lower North Reservoir to the South Reservoir through the 545 pressure zone.

The 545 pressure zone also supplies the Rose Hill 425, 395, 335, and 285 pressure zones through a series of PRVs. It supplies the Bellevue 545 pressure zone through a metered connection at NE 60th Street and 140th Avenue NE, which in turn supplies the Bellevue/Redmond 520 pressure zone through two PRVs.

395 Pressure Zone

The Rose Hill North Reservoir has an overflow of 450 feet, and serves a significant portion of Kirkland's system by gravity. No Redmond customers are served directly from the 450 zone. However, there are two PRVs that supply Redmond's 395 zone from the Kirkland 450 zone.

425 Pressure Zone

The 425 pressure zone is supplied through PRVs from the 545 pressure zone above, and in turn supplies the 335 and 285 pressure zones through a series of PRVs. The 425 pressure zone does not include a storage tank, and the HGL of the zone is maintained by the associated PRVs. The 425 pressure zone also includes an emergency intertie connection with the Bellevue/Redmond 520 pressure zone to the south along 156th Avenue NE near NE 51st Street.

335 Pressure Zone

The 335 pressure zone is supplied through PRV connections to the 425 pressure zone above. The 335 pressure zone is not equipped with a storage tank, and the HGL of the zone is maintained by the associated PRVs.

285 Pressure Zone

The 285 pressure zone is supplied through PRV connections from the 545, 450, 425, and 395 pressure zones above, and includes three metered PRV connections with the 238 pressure zone in the Well Service Area to the east across the Sammamish River: one at Leary Way, one at NE 85th Street, and one at NE 90th Street. The 285 pressure zone does not include a storage tank, and the HGL of the zone is maintained by the associated PRVs. A new intertie with Kirkland was constructed recently, adding a feed to the 285 zone at the intersection of Willows Road and NE 124th Street. This intertie will be connected to the Redmond system when Redmond completes a watermain extension in Willows Road to tie into the existing system. As part of the interlocal agreement to allow this intertie, Redmond has committed to work with Kirkland to determine the best way to operate this zone that is currently operated by both cities.

3.1.3. Overlake/Viewpoint Service Area

The Overlake/Viewpoint Service Area generally includes those portions of the City's water system west of Lake Sammamish, south of NE 51st Street, and north of the Bellevue-Redmond City Limits as shown in Figure 2-2.

Redmond's Overlake/Viewpoint Service Area is interconnected with and supplied from the City of Bellevue water system to the west through a number of metered connections, joint facilities, and distribution lines. Water supply to the Bellevue system is in turn provided through two metered supply connections to the Tolt Eastside Supply Line that supply Redmond: the NE 40th Street supply connection near 140th Avenue NE, and the NE 8th Street supply connection east of 148th Avenue NE. In addition, three connections with Redmond's Rose Hill Service Area can be used to supplement the supplies within the Overlake/Viewpoint Service Area.

Redmond's Overlake/Viewpoint Service Area is divided into five pressure zones with nominal static hydraulic grade line elevations of 335, 415, 435, 465, and 520 as shown in Figure 2-3. The following sections summarize the major pressure zones and water system facilities within the Redmond Overlake/Viewpoint Service Area. Information regarding Redmond's major water system facilities, including source, storage, and transmission installations, are also tabulated toward the end of this section.

520 Pressure Zone

The Bellevue/Redmond 520 pressure zone is supplied primarily through Bellevue's two metered connections to the TESSL as discussed previously. The NE 40th Street supply connection serves the 520 pressure zone through flow- and pressure-reducing control valves which maintain pressures and supply flow rates appropriate for the pressure zone. This supply connection is also equipped with a pump, installed in Bellevue's 670 pressure zone pump station at NE 40th Street, which can supply the 520 pressure zone from the TESSL should supply-line pressures fall to levels insufficient to provide gravity supply.

The NE 40th Street connection also directly supplies the Bellevue/Redmond 6.0-MG prestressed concrete NE 40th Street Reservoir at an HGL of 412.5 feet through an altitude valve. The NE 40th Street Reservoir, located in North Bellevue Community Park between 140th and 148th Avenues NE, serves the Bellevue/Redmond 520 pressure zone through the NE 40th Street Pump Station.

The NE 8th Street supply connection is similarly configured and serves the central portion of Bellevue's 520 pressure zone from the TESSL through flow- and pressure-reducing control valves, which maintain pressures and supply flow rates appropriate for the pressure zone. Each of these supply connections is also equipped with pumps to supply the 520 pressure zone from the TESSL should supply-line pressures fall to levels insufficient to provide gravity supply.

Supplemental supply to the Bellevue/Redmond 520 pressure zone can also be provided as needed from PRV connections to Bellevue's Rose Hill 545 pressure zone, and through the metered emergency intertie connection with the Redmond Rose Hill 425 pressure zone along 156th Avenue NE near NE 51st Street.

Water storage for the Overlake/Viewpoint Service Area is provided through the Bellevue/Redmond 6.0-MG NE 40th Street Reservoir.

Four meter stations, internal to the 520 pressure zone, measure flows between the Bellevue and Redmond systems. One is located on NE 40th just east of SR 520, another is on 156th Avenue NE at NE 36th Street, the third is at 171st Avenue NE and NE 24th Street, and the fourth is located along Bellevue-Redmond Road. The 520 pressure zone also serves Redmond's 465, 415, 435 and 335 pressure zones through a series of PRVs.

465 Pressure Zone

The 465 pressure zone is served from the 520 pressure zone above through PRVs. The zone is not equipped with storage tanks, and the HGL is maintained by the associated PRVs.

415 Pressure Zone

The 415 pressure zone is served from the 520 pressure zone through PRVs, and in turn, supplies the 335 pressure zone below through a series of additional PRVs. The 415 pressure zone does not have a tank, and the HGL within the zone is maintained by the associated PRVs.

435 Pressure Zone

Redmond's small 435 Pressure zone is served from the adjacent Bellevue Lake Hills 435 pressure zone. Redmond's 435 zone is not equipped with storage tanks, and the HGL is maintained by three associated PRVs located in Bellevue's service area. Recently, a 4-inch AC pipe in the 435 pressure zone was abandoned due to multiple breaks occurring over a few years. The pipe connected the waterline in NE 20th Place to one in NE 20th Street and was difficult to repair because it ran between 4 houses. Each break caused damage to the crawl spaces and landscaping of these homes. The abandoned pipe reduced fire flow in the area, so a new 150-foot long 8-inch DI waterline was constructed in 183rd Ave NE from NE 20th Street to a City of Bellevue pipe. The new waterline was completed in the Fall of 2022 and increased fire flows in the pressure zone and provided better redundancy in the area for both cities.

335 Pressure Zone

The Redmond 335 pressure zone serves areas along the shore of Lake Sammamish through PRV connections to the 415 and 520 pressure zones above and through a metered connection to the Rose Hill 335 pressure zone along West Lake Sammamish Parkway NE near NE 51st Street. The zone does not include a tank, and its HGL is maintained by the associated PRVs.

3.1.4. Novelty Hill Service Area

The Novelty Hill Service Area provides water service to the Redmond Ridge, Redmond Ridge East, and Trilogy developments northeast of Redmond along Novelty Hill Road. The Novelty Hill Service Area is supplied through a metered connection to the Seattle Tolt Tie Line along 236th Avenue NE. Water can be supplied to this connection from either of two regional pipelines: Tolt Nos. 1 or 2.

The Novelty Hill Service Area currently has three pressure zones with nominal static hydraulic grade line elevations of 730, 670, and 625 as shown in Figure 2-3. The following sections summarize the major pressure zones and water system facilities in the Novelty Hill service area. Information regarding the major water system facilities, including source, storage, and transmission installations, are also tabulated toward the end of this section.

730 Pressure Zone

The Trilogy Parkway supply connection serves the 730 pressure zone through a flow-and pressure-reducing control valve, which maintains pressures and supply flow rates appropriate for the pressure zone. The Novelty Hill Pump Station's function is to supply the 730 pressure zone from the Tolt Tie Line should pressures in the Tie Line fall below the level required to supply the 730 pressure zone by gravity. The pump station can operate in three different modes: 1. Pump from the Tolt Tie Line to the tanks using flow control based on a level indicator. 2. Pump from the Tolt Tie Line to the distribution system using a variable flow to maintain pressure. 3. Pump from the tanks to the distribution system using a variable flow to maintain pressure.

Water storage for the Novelty Hill service area and the 730 pressure zone is provided by the 3.0-MG and 5.5-MG steel Novelty Hill Standpipe Reservoirs. The pressure zone supplies the 670 and 625 pressure zones through a series of PRVs and includes two existing and one future metered emergency interties serving the Union Hill Water Association water system. The interties are located at Novelty Hill Road and 224th Avenue NE (future), Redmond Ridge Drive and NE 80th Street, and NE 92nd Street and 218th Avenue NE. In addition, water from this zone is wheeled to Sammamish Plateau Water and Sewer District through a metered connection.

670 and 625 Pressure Zones

The Novelty Hill 670 and 625 pressure zones all receive supply from the 730 zone through a series of PRVs. These pressure zones are not equipped with storage tanks, and the HGLs of the zones are maintained by the associated PRVs. The 670 zone can be fed directly off the Tolt Tie Line through a PRV located in the pump station.

There are two metered emergency interties with Woodinville Water District in the 625 pressure zone. One, owned by Woodinville, is located at NE 133rd Street and 277th Avenue NE. The other, owned by Redmond, is located at 232nd Avenue NE and NE 135th Street.

3.2. Supply Wells

The City has five wells, which provide approximately 40 percent of its total supply. Supply provided by these wells serves only the Well Service Area. All five wells were refurbished and updated over the past 20 years. Treatments for all wells include fluoridation, disinfection, and

pH adjustment. Fluoride is used to help with dental hygiene and on-site generation of sodium hypochlorite is used for disinfection at all five wells. Wells 1, 2, 3, and 5 use aeration to elevate pH for compliance of the Lead and Copper Rule. Well 4 adds caustic soda to elevate pH. Also, Well 4 uses a blended phosphate to sequester iron and manganese levels below SMCLs. No additional treatments are needed or planned because all water quality objectives are being met. The physical characteristics of the City's wells are presented in Table 3-2. Information on water rights is provided in Chapter 7.

3.3. Pump Stations

Redmond has a total of nine pump stations that pump water from the City's sources of supply to higher pressure zones and the storage facilities that serve those pressure zones. Table 3-3 shows the physical characteristics of each of the City's pump stations.

3.4. Pressure-Reducing Valves

Operation of the distribution system is controlled largely by pressure-reducing valves, which separate and feed lower pressure zones from higher zones. The City has 84 PRV stations (most of which consist of two valves) in the distribution system inventory including two that are owned by Kirkland, which regulate the flow throughout its water service area. The PRVs, their locations, elevations, pressure settings, and the pressure zones served are listed in Table 3-4.

Table 3-2. Redmond Supply Wells

	Well Information				Well Pump Information				Clearwell Pump Information			
Well (Location)	Casing Diameter (in)	Well Depth (ft)	Static Water Elevation (ft)	Nominal Capacity (gpm)	Pump	Rated Flow (gpm)	Rated Head (ft)	Motor Power (hp)	Pump	Rated Flow (gpm)	Rated Head (ft)	Motor Power (hp)
Well No. 1	24	75	26.5 (winter) 18.5 (summer)	900	Byron Jackson 11MQH 2-Stage Vertical Turbine	900	113	40	Byron Jackson 11MQH 5-Stage	900	289	100
Well No. 2	24	75	27.0 (winter) 19.0 (summer)	500	Byron Jackson 10MQH 3-Stage Vertical Turbine	500	123	30	Byron Jackson 11MQH 5-Stage	900	289	100
Well No. 3	12	47.4	47.83 (winter) 40.83-42.83 (summer)	480	Byron Jackson 10GM 3-Stage Vertical Turbine	533	102	20	Byron Jackson 10MQL 7-Stage	500	246	50
Well No. 4	16	44	41	650	Byron Jackson 11 MQL 5-Stage Vertical Turbine	800	230-260	75	NA	NA	NA	NA
Well No. 5	20	44.2	36.72 (winter) 27.22 (summer)	1,000	Byron Jackson 12MQL 1-Stage Vertical Turbine	1,000	55	25	Byron Jackson 12MQLH 4-Stage	1,200	215	100

Table 3-3. Redmond Pump Stations

Facility	Year Built or Renovated	Supply HGL	Pressure Zone Served	Nominal Pumping Capacity (gpm)	Pump No.	Pump	Rated Flow (gpm)	Rated Head (ft)	Speed (rpm)	Motor Power (hp)	Auxiliary Power
Reservoir Park[5]	2011	238	470	3,000[3]	1	Peerless M12 HXB 7-Stage Vertical Turbine	1,500	260	1,770	125	Hook-up for portable generator
					2	Peerless M12 HXB 7-Stage Vertical Turbine	1,500	260	1,770	125	
					3	Peerless M12 HXB 7-Stage Vertical Turbine	1,500	260	1,770	125	
Perrigo Springs	1962 (2000)	238	470	615	1	Byron Jackson 10-GL3M4 7-Stage VST	615	266	1,760	50	Hook-up for portable generator
					2	Byron Jackson 10-GL3M4 7-Stage VST	615	266	1,760	50	
Education Hill	1997	470	565	2,600[3]	1[4]	PACO 2512-3 Centrifugal	200	135	1,760	15	Yes
					2[4]	PACO 4012-7 Centrifugal	450	135	1,770	40	Yes
					3[4]	PACO 4012-8 Centrifugal	450	135	1,770	40	Yes
				(1500 – Fire Flow)	4	PACO 6012-3 Centrifugal	1,500	135	1,775	75	Yes
				(1500 – Fire Flow)	5	PACO 6012-4 Centrifugal	1,500	135	1,775	75	Yes

Table 3-3. Redmond Pump Stations, Continued

Facility	Year Built or Renovated	Supply HGL	Pressure Zone Served	Nominal Pumping Capacity (gpm)	Pump No.	Pump	Rated Flow (gpm)	Rated Head (ft)	Speed (rpm)	Motor Power (hp)	Auxiliary Power
SE Redmond	1990	238	300	3320[3]	1	Peerless Pump 2AE11	210	70	1,745	10	Yes
				(2,500 – Fire Flow)	2	Peerless Pump 5AE14	680[1]	80	1,190	33.3	Yes
							1,060[2]	185	1,785	75	Yes
					3	Peerless Pump 6AE14	1,325[1]	76	1,190	55.6	Yes
							2,050[2]	175	1,785	125	Yes
					4	Peerless Pump 6AE14	2,050	175	1,777	125	Yes
Rose Hill Supply Station No. 2	2009	TESSL	545	8,000	1	Byron-Jackson	8,000	50	1,200	125	No
					2		8,000	50	1,200	125	No
Rose Hill 650 Zone	2004	545	650	5,250[3]	1	American-Marsh 6x8-12 HD	1,750	129	1,760	75	Yes
					2	American-Marsh 6x8-12 HD	1,750	129	1,760	75	Yes
					3	American-Marsh 6x8-12 HD	1,750	129	1,760	75	Yes
					4	American-Marsh 6x8-12 HD	1,750	129	1,760	75	Yes
					5	American-Marsh 3x4-15 HD	400	129	1,760	25	Yes
					6	American-Marsh 3x4-15 HD	400	129	1,760	25	Yes

Table 3-3. Redmond Pump Stations, Continued

Facility	Year Built or Renovated	Supply HGL	Pressure Zone Served	Nominal Pumping Capacity (gpm)	Pump No.	Pump	Rated Flow (gpm)	Rated Head (ft)	Speed (rpm)	Motor Power (hp)	Auxiliary Power
Rose Hill North Reservoir	Rebuilt 1991	450	545	2,500	1	Byron-Jackson	2,500	182	1,800	150	No
Bellevue/ Redmond NE 40th St.	1991	412.5	520	6,000	1[4]	Johnston VTP	2,000	142	1,760	100	Yes
					2[4]	Johnston VTP	4,000	142	1,760	200	Yes
					3[4]	Johnston VTP	4,000	142	1,760	200	Yes
					4	Future (not installed)					Yes
Novelty Hill	1999	Tolt	730	7,500[3]	1[4]	Byron-Jackson	2,500	128	1,780	150	Yes
					2[4]	Byron-Jackson	2,500	128	1,780	150	Yes
					3[4]	FloServe	3,250	180	1,800	200	Yes
					4[4]	FloServe	3,250	180	1,800	200	Yes
					5[4]	FloServe	3,250	180	1,800	200	Yes

NA = Data Not Available
[1] At full speed
[2] At reduced speed
[3] See Operation and Maintenance Manual for range of operating conditions and pump performance at varying speeds.
[4] Controlled via variable frequency drive (VFD).
[5] Replacement station is under construction.

Table 3-4. Pressure Reducing Valves

Pressure Reducing Valve Settings												
Location	PRV Number	Zone		Size (in)	Downstream Setting (psi)	Node Elevation (ft)1929	Node Elevation (ft)1988	Existing HGL (ft)	Proposed PRV Setting (psi)	Proposed HGL (feet)	Pressure Sustaining Valve	Comments
		From	To									
ROSE HILL SERVICE AREA PRVs												
NE 100th St. & 134th Ave NE	48	545	425	3	60	287.00	290.61	425.60			Yes	
				6	55	287.00	290.61	414.05				
NE Redmond Way & 140th Ave NE	49	545	425	3	61	284.87	288.48	425.78			No	
				6	56	284.87	288.48	414.23				
NE 80th St. & 140th Ave NE	50	545	425	3	64	277.00	280.61	424.84			Yes	
				6	59	277.00	280.61	413.29				
140th Pl NE & NE 73rd St.	51	545	425	2	46	318.73	322.34	424.99			No	
				6	41	318.73	322.34	413.44				
148th Ave NE & Old Redmond Rd. (Grasslawn Park)	52	545	425	2	58	290.28	293.89	424.26			Yes	
				8	53	290.28	293.89	412.71				
NE 64th St. & 151st Ave NE, Spiritbrook	53 *	545	425	3	60		287.20	138.60			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				8	55		287.20	127.05				
SR 520 & NE 51st St.	54	545	425	3	43		333.20	432.53			Yes	Part of DRLE EWA Plans (332.82'invert+0.377'half of 8"pipe diameter=333.2')
				8	41		333.20	427.91				
NE 97th St. & 132nd Ave NE	55 *	545	425	2	57		289.90	131.67			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	52		289.90	120.12				
132nd Ave NE & NE 92nd St.	56	545	425	2	40	333.03	336.64	425.43			No	
				4	35	333.03	336.64	413.88				
152nd Ave NE behind MSFT bldg, Redmond West, off 148th	59	545	425	2	65	274.20	277.81	424.35			Yes	
				8	60	274.20	277.81	412.80				
132nd Ave NE & NE 92nd Ct, Walden Ridge	66	545	425	2	55	299.00	302.61	426.05			Yes	
				6	50	299.00	302.61	414.50				
136th Ave NE & NE 102 St.	67	545	425	2	56	297.00	300.61	426.36			Yes	
				6	51	297.00	300.61	414.81				
NE 51st St. & 162 Ave NE	35	425	335	4	65	184.10	187.71	334.25			No	
				10	60	184.10	187.71	322.70				
159th Ave NE & NE 55th Way	36 *	425	335	2	64		179.60	147.84			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	59		179.60	136.29				
NE 59th Pl. & NE 158th Way South Meadows	37 *	425	335	2	57		205.53	131.67			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	52		205.53	120.12				
NE 65th St. & NE 157th Pl. North Meadows	38 *	425	335	2	67		182.00	154.77			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	62		182.00	143.22				

Pressure Reducing Valve Settings

Location	PRV Number	Zone		Size (in)	Downstream Setting (psi)	Node Elevation (ft)1929	Node Elevation (ft)1988	Existing HGL (ft)	Proposed PRV Setting (psi)	Proposed HGL (feet)	Pressure Sustaining Valve	Comments
		From	To									
Old Redmond Rd. btwn hse#143 & 144, Walnut Hills	39	425	285	3	49	172.49	176.10	285.68			No	
				8	44	172.49	176.10	274.13				
NE 75th St. & 153rd Ave NE, Guall Val Condos, off Old Red Rd	40	425	285	3	54	160.35	163.96	285.09			No	
				8	49	160.35	163.96	273.54				
NE Redmond Way & Willows Rd	41	425	285	3	69	125.02	128.63	284.41			No	
				8	64	125.02	128.63	272.86				
149th Pl NE & NE 48th St., Scarborough Apts., off Willows Rd.	42	425	285	3	70	122.84	126.45	284.54			No	
				8	65	122.84	126.45	272.99				
Red-Kirk Way & 148th Ave NE, Samm. Ridge Condo's	43	425	285	3	78	105.55	109.16	285.73			No	
				8	73	105.55	109.16	274.18				
Willows Rd. behind bldg #9911, Opus	63	425	285	2	85	88.30	91.91	284.65			Yes	
				8	80	88.30	91.91	273.10				
NE 124th St. & 135th Ave NE, Four Wheel Drive Store	*45*	*395*	*285*	*3*	*67*	*130.00*	*133.61*	*284.77*			*Yes*	
Now Owned by Kirkland				*8*	*62*	*130.00*	*133.61*	*273.22*				
Willows Road & 140th Ave NE (by RxR tracts)	*46*	*395*	*285*	*3*	*75*	*112.62*	*116.23*	*285.87*			*No*	
Now Owned by Kirkland				*8*	*70*	*112.62*	*116.23*	*274.32*				
Behind Primax Research Bldg in grass	44	545	285	3	66	133.29	136.90	285.75			Yes	
				8	61	133.29	136.90	274.20				
Explosive testing area off Willows Rd., Primex	64	450	285	3	67	130.76	134.37	285.53			Yes	
				10	62	130.76	134.37	273.98				
142nd Ave NE & NE 86th St., Cedar Homes	155	425	285	2		150.74	154.35	150.74	58	285	Yes	
(OFF LINE)				6			3.61					
BELLEVUE OVERLAKE VIEWPOINT PRVs												
156 th Ave SE & NE 48th St., North Ravenswood	19	520	465	3	65	314.98	318.59	465.13			No	
				8	60	314.98	318.59	453.58				
156 th Ave SE & NE 46th St., South Ravenswood	20	520	465	3	65	313.87	317.48	464.02			No	
				8	60	313.87	317.48	452.47				
NE 40th St. & 162nd Ave NE	14 *	520	415	3	49		303.40	113.19			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				8	44		303.40	101.64				
163rd Ave NE & NE 36th Way	22	520	415	4	43	315.32	318.93	414.65			No	
				10	38	315.32	318.93	403.10				
Bellevue-Redmond Rd. & NE 32nd St.	34	520	415	3	42	317.69	321.30	414.71			Yes	
				8	37	317.69	321.30	403.16				

Pressure Reducing Valve Settings

Location	PRV Number	Zone From	Zone To	Size (in)	Downstream Setting (psi)	Node Elevation (ft)1929	Node Elevation (ft)1988	Existing HGL (ft)	Proposed PRV Setting (psi)	Proposed HGL (feet)	Pressure Sustaining Valve	Comments
NE 24th St. & 178th Ave NE, 17769	10	520	335	1.5	51	217.31	220.92	335.12			Yes	
				6	46	217.31	220.92	323.57				
NE 30th Pl. & 177th Ave NE, Tiburon	16	520	335	1.5	49	215.56	219.17	328.75			Yes	
				6	44	215.56	219.17	317.20				
NE 28th Pl. & NE 173rd CT.	23 *	520	335	2	47		224.30	108.57			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	42		224.30	97.02				
Bellevue-Redmond Rd. & NE 40th St., 163rd	15 *	415	335	2	75		156.40	173.25			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	70		156.40	161.70				
NE 46th St. & 164th Pl. NE	17	415	335	2	51	210.23	213.84	328.04			Yes	
				8	46	210.23	213.84	316.49				
WELL SERVICE AREA PRVs												
160th Ave NE & NE 105th CT.	9	470	390	1.5	57	259.42	263.03	391.09			Yes	
				6	52	259.42	263.03	379.54				
161st Ave NE & NE 109th St.	13 *	470	390	2	63		244.80	145.53			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	58		244.80	133.98				
158th Ave NE & NE 116th St., Pyke Property	65	470	390	2	68	232.46	236.07	389.54			Yes	
				8	63	232.46	236.07	377.99				
NE 122th St. & 164th Ct. NE - Cooper (Woodlands Ridge)	70	470	390	2	66	237.50	241.11	389.96			Yes	
				8	61	237.50	241.11	378.41				
NE 116th St. & 162nd Ave. NE - (Greystone)	75	470	390	2	64	241.00	244.61	388.84			Yes	
				6	59	241.00	244.61	377.29				
180th Ave NE & NE 98th St., COUNTRY ROUTE Perrigo Springs	1	470	350	3	64	198.53	202.14	346.37			No	
				8	59	198.53	202.14	334.82				
166th Ave NE & between NE 92nd and 95th St. (by church)	3	470	350	2	40	259.00	262.61	351.40			Yes	
				8	35	259.00	262.61	339.85				
168th Ave NE & NE 88th St.	4	470	350	4	59	214.47	218.08	350.76			Yes	
				4	54	214.47	218.08	339.21				
176th Pl. NE & NE 116th St.	7	470	350	2	58	216.74	220.35	350.72			Yes	
				8	53	216.74	220.35	339.17				
171st Ave Ne & NE 84th St.	8	470	350	3	64	203.00	206.61	350.84			Yes	
				6	59	203.00	206.61	339.29				
172nd Ave NE & NE 82nd St.	11	470	350	1.5	40	259.00	262.61	351.40			Yes	
				6	35	259.00	262.61	339.85				
NE 104th St. & 182nd Ave NE	12 *	470	350	2	47		224.60	108.57			Yes	Part of PRV Phase 1 project. Plans were in NAVD88.
				6	42		224.60	97.02				
NE 95th CT & 163rd Avenue NE, 4 MG Driveway	18	470	350	1.5	56	221.00	224.61	350.36			Yes	
				6	51	221.00	224.61	338.81				

Pressure Reducing Valve Settings

Location	PRV Number	Zone From	Zone To	Size (in)	Downstream Setting (psi)	Node Elevation (ft)1929	Node Elevation (ft)1988	Existing HGL (ft)	Proposed PRV Setting (psi)	Proposed HGL (feet)	Pressure Sustaining Valve	Comments
181st Ave NE & NE 107th St.	21	470	350	2	47	241.43	245.04	350.00			No	
				6	42	241.43	245.04	338.45				
NE 99th St. & 183rd Ave NE, Hidden Ridge	24	470	350	2	56	220.71	224.32	350.07			No	
				6	51	220.71	224.32	338.52				
NE 164th Ave & NE 95th St., Vineyards	25	470	350	2	80	166.09	169.70	350.89			Yes	
				8	75	166.09	169.70	339.34				
178th Pl NE & NE 109th Ct., Abbey Road	26	470	350	2	56	219.70	223.31	349.06			Yes	
				6	51	219.70	223.31	337.51				
176th Ave NE & NE 120th Way	68	470	350	2	52	229.75	233.36	349.87			Yes	
				6	47	229.75	233.36	338.32				
177th Pl NE & NE 114th St (under construction)	69	470	350	2	46	243.00	246.61	349.26			Yes	
				6	41	243.00	246.61	337.71				
169th Pl NE - North of NE 84th Ct. Shaughnessy Heights (North PRV)	72	470	350	2	60	201.00	204.61	339.60			Yes	
				8	55	201.00	204.61	328.05				
176th Ave. NE - NE 122nd St. Willowmere	76	470	350	2	48	239.00	242.61	349.88			Yes	
				6	43	239.00	242.61	338.33				
160th Ave NE, end of road, River Trails (NOT CONNECTED YET)	154	390	238	2		37.81	41.42	37.81	87	238	Yes	
				8			3.61					
SR202, 1,100ft South of 124th Ave. NE WASHINGTON CATHEDRAL	157	390	238	2	50	122.00	125.61	237.50		122	Yes	
				8	45	122.00	125.61	225.95				
166th Ave NE & NE 87th St. (behind locked gate)	2	350	238	2	51	100.81	104.42	218.62			Yes	
				8	46	100.81	104.42	207.07				
172nd Ave NE & NE 80th St., 17121	5	350	238	2	56	109.00	112.61	238.36			Yes	
				8	51	109.00	112.61	226.81				
NE 100th CT. & 183rd Ave NE, Avon Trace	27	350	238	3	56	89.71	93.32	219.07			Yes	
				8	51	89.71	93.32	207.52				
Avondale Rd & NE 116th St in new Apt complx, South Pit	57	350	238	2	39	127.79	131.40	217.88			Yes	
				8	34	127.79	131.40	206.33				
Avondale Rd & NE 116th St in new Apt complx, North Pit	58	350	238	2	40	125.81	129.42	218.21			Yes	
				8	35	125.81	129.42	206.66				
NE 104th St btwn Avondale and 183rd Ave NE	62	350	238	2	38	130.40	134.01	218.18			Yes	
				8	33	130.40	134.01	206.63				
NE 90th Pl. & Avondale Rd in apt complx, The Heights	151	350	238	2	51	120.98	124.59	238.79			Yes	
				8	46	120.98	124.59	227.24				
169th Ave NE - North of NE 82nd St Shaughnessy Heights (South PRV)	73	350	238	2	53	108.00	111.61	230.43			Yes	
				8	48	108.00	111.61	218.88				

Pressure Reducing Valve Settings

Location	PRV Number	Zone From	Zone To	Size (in)	Downstream Setting (psi)	Node Elevation (ft)1929	Node Elevation (ft)1988	Existing HGL (ft)	Proposed PRV Setting (psi)	Proposed HGL (feet)	Pressure Sustaining Valve	Comments
Genie Industries by water tank	47	300	SE238	3	35	136.68	140.29	217.53			Yes	
				8	30	136.68	140.29	205.98				
Redmond Fall City Rd in English Hill Apt bldg	61	300	SE238	2	52	98.63	102.24	218.75			Yes	
				8	48	98.63	102.24	209.51				
76th St. NE - between 185th & 188th Ave. NE Taylor Short Plat	74	300	SE238	2	73	56.37	59.98	225.00			Yes	
				8	68	56.37	59.98	213.45				
18200 Union Hill Road (Millenium) (NOT CONNECTED YET)	150	300	SE238	2	83	45.82	49.43	237.55	83	238	Yes	
				8	78	45.82	49.43	226.00				
162nd Ave NE & NE 98th St.	6	470	315	2	42	218.75	222.36	315.77			Yes	
				8	37	218.75	222.36	304.22				
Millenium NW Parking Lot next to Bear Creek SE Redmond Transmission Main	71	470	300	3	111	46.80	50.41	303.21			Yes	
				8	106	46.80	50.41	291.66				
				8	101	46.80	50.41	280.11				
				8	96	46.80	50.41	268.56				
Ashford Park, South of 180th * HIGH PRESSURE ISSUES *	152	470	285	3	80	98.03	101.64	282.83			Yes	
				8	75	98.03	101.64	271.28				
180th Ave NE & NE 98th St., Perrigo Springs (FLOW CONTROL)	153	470	238	10	15	202.53	206.14	237.18				
4 MGR North Pit (FLOW CONTROL)	31	470	238	10							Yes	
Ashford Park, North of 180th	156	285	238	2	53	109.00	112.61	231.43			Yes	
				8	48	109.00	112.61	219.88				
NOVELTY HILL (TRILOGY) PRVs												
239th Avenue NE, Serpentine Road North of 18th Tee Trilogy Package 4 South	T4	730	670	2	62	527.42	531.03	670.64			Yes	
				8	57	527.42	531.03	659.09				
East of Sun Break Way NE on NE 126th Street	T5	730	670	2	50	554.40	558.01	669.90			Yes	
				8	45	554.40	558.01	658.35				
North of NE Novelty Hill Road along 242nd Place NE	T6	730	670	2	77	493.23	496.84	671.10			Yes	
				8	72	493.23	496.84	659.55				
Sun Break Way NE, North of NE 30th Street	T1	670	625	2	58	491.98	495.59	625.96			Yes	
				8	53	491.98	495.59	614.41				
L to K, along Adair Creek Way NE	T2	670	625	2	91	414.26	417.87	624.47			Yes	
				8	86	414.26	417.87	612.92				
Trilogy Parkway North, North of NE 129th Court	T3	670	625	2	81	438.10	441.71	625.21			Yes	
				8	76	438.10	441.71	613.66				

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3.5. Storage Facilities

The City currently has ten storage facilities, which provide storage for all four of its service areas. Three of the tanks are joint-use facilities with the cities of Bellevue and Kirkland.

3.5.1. Education Hill Tank Nos. 1 and 2

The Education Hill reservoirs serve the 470 pressure zone. Both tanks are of steel construction and have a combined volume of 5.0 MG. Tank No. 1 is a 2.0-MG tank, constructed in 1962 of steel-plating set on a concrete ring wall foundation. This tank has a height of 70 feet and is 70 feet in diameter. Tank No. 2 was constructed in 1988 to provide additional storage volume at the Education Hill site. This tank has a 3.0-MG volume and was constructed directly adjacent to Tank No. 1. It is of steel-plate construction set on a concrete ring wall foundation, has a height of 70 feet, and is 86 feet in diameter.

The Education Hill Booster Pump Station is located on the site to supply water to the adjacent 565 pressure zone. Valving and yard piping at the site allow isolation of either tank for cleaning and related maintenance functions. In 1990, several improvements were made at the site as part of the project to connect Redmond's distribution system to Tolt Pipeline No. 2. An altitude valve was added to prevent overfilling of the tanks. The altitude valve included a pressure-relief pilot that is set to automatically discharge into the tanks. This feature was added to prevent exposing the 470 pressure zone to full Tolt Pipeline hydraulic head in the event of a malfunction at the pressure-control vault on NE 104th Street. Pump outlets were also added at each tank outlet to facilitate transfer of water out of the tanks in preparation for cleaning or other maintenance activities that require draining the tanks.

The two Education Hill tanks have been cleaned and painted twice within the last 20 years and as a result, are in good condition. In 1988, the outside of Tank No. 1 was cleaned and painted. In 1997, divers inspected both tanks, and cleaned the inside. Very little sediment was found inside the tanks, presumably because the water is supplied from the wells. In 1998, both tanks had problems with the paint adhering to the primer. Therefore, both tanks were thoroughly cleaned and painted in 2008.

In 1992, Education Hill Tank No. 1 was completely retrofitted around the base. A new footing was poured, bringing the tank up to current seismic requirements at that time.

As part of the tank painting project in 2008, Tank No. 2 was completely retrofitted around the base with a new footing and metal stiffeners in the upper sections. Metal stiffeners were also installed in Tank No. 1. Furthermore, safety upgrades were also completed as part of this project. Ladder guards, handrails, platforms, larger access hatches, davit arms, and additional venting were all added to both tanks to improve safety for the maintenance personnel. A dechlorination manhole, rainwater downspouts, and cable trays were also constructed, along with reconstruction of the Tank No. 2 overflow, as part of the tank painting project in 2008. Both tanks now meet current safety, operational, and seismic requirements.

3.5.2. Reservoir Park Tank

The Reservoir Park Tank is a 4.0-MG tank constructed in 1976. It is a buried concrete facility with a height of 30 feet, and serves the 238 pressure zone. This tank was originally designed to be fed by the groundwater well supply in the 238 pressure zone. An on-site booster pump

station lifts water from the tank into the 470 pressure zone. Prior to Redmond's connection to Tolt Pipeline No. 2, this facility was the primary supply point for the City's 470 pressure zone. As part of the Tolt Pipeline No. 2 connection, flow and pressure control valves were added to regulate flow of water from the 470 pressure zone into the 238 pressure zone.

The tank hatch was replaced in 2003. Divers inspected the tank in 2005. Although no problems were identified, the tank is known to not meet current seismic design requirements. Therefore, a structural evaluation of the tank was done in conjunction with the Reservoir Park Booster Pump Station design project. Also as a part of the pump station design project, a new outlet pipe was designed. The latter improvement allows the tank to operate with separate inlet and outlet pipes. Seismic improvements to the reservoir were done and a new pump station was constructed in 2011 to address the deficiencies identified in the evaluation. The tank was again cleaned in 2022.

3.5.3. Perrigo Springs Tank

The Perrigo Springs Tank is a 0.5-MG tank that was constructed in 1962. It is of steel plate construction, with a diameter of approximately 53 feet and a height of 30 feet. This facility is supplied through a 16-inch pipeline, which is fed by the Well Service Area. This tank serves customers located along Avondale Road in the 238 pressure zone.

In 1999, a 20-inch pipeline, altitude valve, flow control valve, and pressure reducing valves (PRV) were constructed at the tank. The flow control valve allows the 470 zone water to supply the 238 zone through a 20-inch pipe from the Education Hill Tanks. A 12-inch pipeline and PRVs were also installed to supply water to the 350 zone.

The tank was painted both inside and out in 2007, as part of the Education Hill Tank Painting Project

3.5.4. SE Redmond Tank

The 3.5-MG SE Redmond Tank was constructed in 1996 . It is a steel tank with a diameter of 107 feet and a height of 67 feet. It serves the 238 zone along with the Perrigo Springs and Reservoir Park Tanks.

The SE Redmond Tank uses a series of valves to control flow in and out of the tank. A flow control valve is used to bring water into the tank from the 300 zone. An altitude valve is used to bring water into the tank from the 238 zone while another flow control valve is used to move water from the tank to the 238 zone. There is also a pressure reducing valve that would open in the event of a pressure drop (i.e. from a fire) in the 238 zone that would allow higher flows from the tank into the 238 zone.

The tank was repainted and received a seismic retrofit in 2021. Work included installation of a seismic valve to shut the tank off in the event of an earthquake.

3.5.5. Novelty Hill Tanks

The Novelty Hill Tank No. 1 is a 3.0-MG tank constructed in 1999. It is of steel plate construction, with a diameter of approximately 65 feet and a height of 138 feet. It serves the 730 pressure zone.

The No. 2 Tank is a 5.5-MG tank constructed in 2002. It is of steel plate construction, with a diameter of approximately 82 feet and a height of 138 feet. It also serves the 730 pressure zone.

Water from the Tolt Tie Line can supply these tanks via gravity much of the time, but when the Tolt's pressure is too low, water is pumped from the Novelty Hill Pump Station to the tanks. Water entering the tanks is controlled by two altitude valves (one for each tank). A transfer pumping system and re-chlorination system can re-circulate water to keep it fresh or transfer water from one tank to another. An On-Site Generation of Sodium Hypochlorite system is used to re-chlorinate the water if the chlorine residual is low.

3.5.6. Bellevue/Redmond NE 40th Street Tank

This tank is a joint-use facility that serves the Bellevue and Redmond 520 pressure zones. Constructed in 1991 of prestressed concrete, it has a height of 30 feet, diameter of 170 feet, and a total storage volume of 6.0 MG. The storage facility includes an on-site pump station that boosts water to the 520 pressure zone. The reservoir's pumped storage that does not float on the zone, so it requires the on-site NE 40th Reservoir Pump Station to operate. Also NE 40th Inlet Station is part of the joint-use facilities, and supplies the site with water directly from SPU's Tolt Eastside Supply Line. Recent maintenance work on the tank included filling of holes in the base of the tank from original construction, roof maintenance, and upgrades to the control valve and inlet meter.

As a joint-use facility the two cities share the costs of maintenance and any improvements that are required. Redmond's allocated storage volume is 2.64 MG.

3.5.7. Rose Hill North Reservoir

The Rose Hill North Reservoir is a joint-use tank shared by Redmond and Kirkland. It is a steel tank built in 1994 with a 154-foot diameter, a height of 103 feet, and a total volume of 14.3 MG. The reservoir serves Redmond's 285 and 395 zones and Kirkland's 450 pressure zone.

The 2001 Nisqually earthquake caused the floor plate of the tank to leak. This leak was repaired, and a seismic upgrade project was completed in 2010, along with a tank painting project.

As a joint-use facility the two cities share the costs of maintenance and any improvements that are required. Redmond's allocated storage volume is 4.18 MG.

3.5.8. Rose Hill South Reservoir

Similar to the Rose Hill North Reservoir, this reservoir is a joint-use facility shared by Redmond, Kirkland, and Bellevue. It is a steel tank built in 1971 with a diameter of 195 feet, a height of 50 feet, and a total volume of 11.2 MG. The tank has an overflow elevation of 545. As a joint-use facility, the cities share the costs of maintenance and any improvements that are required. Redmond's allocated storage volume is 2.41 MG.

Table 3-5 summarizes the physical characteristics of each of the City's storage facilities.

3.6. Distribution Mains

The City has approximately 340 miles of distribution mains. Table 3-6 shows an inventory of the City's distribution mains, showing the length of pipe by material and diameter.

3.7. Interties and Supply Connections

The City currently has seven supply connections to the regional supply system, which supplement the supply provided by the wells. Two connections to SPU's Tolt Pipeline No. 2 (TPL#2) serve the Well Service Area. Three connections to SPU's Tolt Eastside Supply Line (TESSL) serve the Rose Hill service area. These three connections are shared with Kirkland. An additional connection to the TESSL (at NE 40th St.) serves the Overlake/Viewpoint service area, and is shared with the City of Bellevue. The City's final supply connection is to SPU's Tolt Tie Line and serves Novelty Hill. Table 3-7 shows all of the City's supply connections.

The operating hydraulic grade varies in the regional transmission system based on overall regional demands and operation of SPU's Tolt filter plant at the upstream end of the regional system. At Redmond's supply connections, the hydraulic grade can vary considerably, from less than 500 feet to over 700 feet. When the hydraulic grade in the regional system is high, much of the City can be fed by gravity. At lower hydraulic grades in the regional system, booster pump stations are used. Cascade's agreement with Seattle includes specified minimum contractual heads (MCHs) at each supply station.

In addition to its supply connections with the regional supply system, the City has a number of both non-emergency and emergency interties with adjacent purveyors. These are shown in Table 3-8. Interties are defined in WAC 246-290-010 as "an interconnection between public water systems permitting the exchange or delivery of water between those systems." Prior to 1991, interties were established between utilities on an as-needed basis and no process was in place at the state level for review or approval. Since that time, DOH and the Washington State Department of Ecology have developed review and approval requirements.

Potential future interties are also shown in Table 3-8 and discussed further in Chapter 7. Locations for any new interties between the City and adjacent jurisdictions will be determined jointly by the parties involved.

Table 3-5. Redmond Storage Tanks

Facility	Type	Year Built / Year Improved	Total Volume (MG)	Percent Redmond	Redmond Volume (MG)	Diameter (ft)	Overflow Elevation (ft)	Base Elevation (ft)
Perrigo Springs	Steel	1962 / 1999 / 2007	0.5	100%	0.5	53	238	208
Reservoir Park	Buried Prestressed Concrete	1976 / 2011	4.0	100%	4.0	160	238	208
SE Redmond	Steel	1996/2021	4.5	100%	4.5	107	238	170.6
Education Hill No. 1	Steel	1962 / 1992 & 2008	2.0	100%	2.0	70	470	400
Education Hill No. 2	Steel	1988 / 2008	3.0	100%	3.0	86	470	400
Rose Hill South Reservoir	Steel	1971	11.2	21.5%	2.41	195	545	495
Rose Hill North Reservoir	Steel	1994	14.3	29.2%	4.18	154	450	347
Bellevue/Redmond NE 40th Street	Partially Buried Prestressed Concrete	1991	6.0	44%	2.64	170	412.5	376.5
Novelty Hill Tank No. 1	Steel	1999	3.0	100%	3.0	65	730	592.5
Novelty Hill Tank No. 2	Steel	2002	5.5	100%	5.5	82	730	592.5

Table 3-6. Distribution System Pipe Inventory (End of 2022)

Diameter (inches)	Total Length in System (feet)	Material						
		AC	CI	DI	PE	PVC	STL	Unknown
In-City Service Area								
Unknown	920			195				725
4	47,580	25,849	3,517	16,802		866		547
6	207,425	111,170	19,746	73,642	4	694		2,169
8	601,593	107,068	31,045	455,382	393	2,005		5,700
10	40,506	21,475		18,379				652
12	503,255	6,327	9,070	487,077		313		469
14	9357	7,553		1,738				66
16	58,278	5,614	313	52,227	2			122
20	24,330			24,330				
24	352			352				
28	1,518				1,518			
Subtotal	**1,495,115**	**285,056**	**63,691**	**1,130,122**	**1,917**	**3,878**		**10,451**
Jointly Owned Pipes with Bellevue								
6	856	41		816				
8	2,273	2,010		264				
10	6,124	6,081		35				8
12	4,608	1,338		3,270				
14	1,638		1,629	9				
16	709			709				
Subtotal	**16,209**	**9,469**	**1,629**	**5,103**				**8**
Jointly Owned Pipes with Kirkland								
6	274			261				14
8	296	156	31	109				
10	8			8				
12	2,883		15	2,868				
16	13,489			13,489				
18	145			145				
20	4,204			4,204				
24	4,378			4,378				
Subtotal	**25,678**	**156**	**46**	**25,462**				**14**

Novelty Hill Service Area								
4	736			736				
6	9,809			9,809				
8	102,814			102,633	181			
10	32			32				
12	107,994			107,242	751			
16	6,336			6,336				
20	6,272			6,233			39	
24	13,872			13,712			160	
Subtotal	**247,865**			**246,733**	**932**		**199**	

AC = asbestos cement
CI = cast iron
DI = ductile iron
PVC = polyvinyl chloride
STL = steel

Table 3-7. Supply Connections to SPU Transmission Pipelines

Name	Supply Pipeline	Tap Size (in)	Purpose	Minimum Contract Head (ft)[1]	Pressure Zones Served	Flow Capacity (gpm)
Education Hill	TPL #2	10	Service to Education Hill and Well Service Area	515 (505)	470	5,000
Education Hill	TPL#2	16	Service to Education Hill and Well Service Area	515 (505)	470	5,000
Rose Hill No. 1	TESSL	10	Service to Bellevue/Kirkland/ Redmond Rose Hill Service Area	520 (510)	545 & 650	3,500[3] (1,498 to Redmond - 42.8%)
Rose Hill No. 2	TESSL	10	Service to Bellevue/Kirkland/ Redmond Rose Hill Service Area	535 (525)	545 & 650	8,000 (2,720 to Redmond - 34%)
Rose Hill No. 3	TESSL	10	Service to Bellevue/Kirkland/ Redmond Rose Hill Service Area	555 (545)	545	4,500 (1,530 to Redmond - 34%)
Overlake	TESSL	10	Service to Bellevue & Redmond's Overlake/Viewpoint Service Area	520 (510)	520	5,000[4]
Novelty Hill	Seattle Tolt Tie Line[2]	16 16	Service to Novelty Hill	610 (600)	730	7,900

[1] Minimum hydraulic grade line (HGL) per SPU datum, followed in parentheses by the minimum HGL per Redmond's datum.

[2] There are two meters at the Novelty Hill connection to the Tolt Tie Line.

[3] Kirkland's water system plan says "contract percentage is the contractual ownership interest of each City, per the Rose Hill Water Distribution Assumption Agreement."

[4] Shared with Bellevue.

Table 3-8. Interties to Adjacent Purveyors

Location	Connection	Meter Size (in.)	Purpose
Existing Interties			
Many interconnections	City of Bellevue	Varies	Non-emergency / Regional conveyance
Many interconnections	City of Kirkland	Varies	Non-emergency / Regional conveyance
NE 95th St. near 195th Ave. NE	Union Hill Water Association	6	Emergency
Novelty Hill Rd. and 224th Ave. NE *(Union Hill plans to install in future)*	Union Hill Water Association	TBD	Emergency
Redmond Ridge Dr. and NE 80th St.	Union Hill Water Association	8	Emergency (two-way)
NE 93rd St. and 221st Pl.	Union Hill Water Association	6	Emergency (two-way)
187th Ave. NE	Northeast Sammamish Sewer and Water District	6	Emergency
South end of Redmond Ridge	Sammamish Plateau Water and Sewer District	8	Non-emergency / Regional conveyance
NE 133rd St. and 227th Ave. NE	Woodinville Water District (owned by Woodinville)	8	Emergency (one-way, to Woodinville)
232nd Ave. NE and NE 135th St.	Woodinville Water District (owned by Redmond)	8	Emergency (two-way)
Potential Future Interties (Connection date to be determined)			
172nd Ave. NE and two or more other locations along service area boundary	Woodinville Water District	TBD	Emergency
Location to be determined	Sammamish Plateau/ Dawnbreaker	TBD	Emergency

TBD = To be determined

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Chapter 4: Planning Data and Demand Forecast

City of Redmond 2023 Water System Plan DRAFT

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4. Planning Data and Demand Forecast

This chapter discusses planning data and the City of Redmond's demand forecast. The information is presented in three main sections: the first section summarizes demographic data for Redmond; the second section summarizes Redmond's water use characteristics; and the third section combines the demographics and the water supply characteristics to develop Redmond's demand forecast.

As described in Chapter 3, Redmond retails water in two areas. The first area is the City Service Area, which approximates the City's municipal boundaries. The second area is the Novelty Hill Service Area, which is a planned community east of the City in unincorporated King County. These two areas are collectively referred to as the Combined Service Area. The information in this chapter distinguishes between the City, the Novelty Hill, and the Combined Service Areas.

Water system plans typically provide demand forecasts for a 20-year planning period. The plans are specifically required to provide forecasts for a base year through year ten and year 20 of the 20-year planning period. For this plan, 2023 was selected as the base year, with 2033 and 2043 representing the 10- and 20-year forecast horizons. Data used in this chapter do not include year 2022 because those data were not available during plan production.

The demand forecast developed in this chapter is used in the water rights evaluation in Chapter 7.2, in the source capacity evaluation in Chapter 10, and in documenting the City's water conservation program savings.

4.1. Demographics – Historical and Projected

The following four demographic units were analyzed for the City Service Area:

- Population
- Single Family Households
- Multifamily Households
- Employment

Households and employment are used directly in forecasting demand. The population numbers were not used directly for the demand forecast; however, they are provided to meet DOH water system planning requirements.

Table 4-1 presents historical and projected demographic numbers for the City Service Area. The values are based primarily on data developed between the City's planning department and the Puget Sound Regional Council (PSRC). Historical demographic data were estimated for 2010 and several years between 2018 and 2022; blue cells in Table 4-1 indicate where historical demographics were estimated. Forecasted demographics for single family households, multifamily households, and employment were provided for 2050. Demographic data for the years between the estimates were interpolated using linear growth between milestones.

Demographic projections were not developed for the Novelty Hill Service area. King County confirmed there is not appreciable capacity for the area to grow further over the next 20 years. See Section 3.3.1 for more information on the demographic units for the Novelty Hill Service Area and their application in the demand forecast.

Table 4-1. Demographics (City Service Area Only)

Calendar Year	Plan Year	Population [a]		Single Family (SF) Households [b]		Multifamily (MF) Households [b]		Employment [c]	
		Quantity	Annual Change	Quantity	Annual Change	Quantity	Annual Change	Quantity	Annual Change
2010	n/a	54,144	n/a	11,948	n/a	12,229	n/a	76,313	
2011		56,055	3.5%	11,877	-0.6%	12,863	5.2%	78,445	2.8%
2012		57,966	3.4%	11,806	-0.6%	13,497	4.9%	80,577	2.7%
2013		59,878	3.3%	11,735	-0.6%	14,131	4.7%	82,709	2.6%
2014		61,789	3.2%	11,664	-0.6%	14,765	4.5%	84,841	2.6%
2015		63,700	3.1%	11,592	-0.6%	15,399	4.3%	86,973	2.5%
2016		65,611	3.0%	11,521	-0.6%	16,033	4.1%	89,105	2.5%
2017		67,522	2.9%	11,450	-0.6%	16,667	4.0%	91,237	2.4%
2018		69,434	2.8%	11,379	-0.6%	17,301	3.8%	93,369	2.3%
2019		71,345	2.8%	12,543	10.2%	17,495	1.1%	95,501	2.3%
2020		73,256	2.7%	13,706	9.3%	17,689	1.1%	96,444	1.0%
2021		74,475	1.7%	13,794	0.6%	18,331	3.6%	98,573	2.2%
2022		75,694	1.6%	13,811	0.1%	19,009	3.7%	99,273	0.7%
2023	0	76,913	1.6%	13,762	-0.4%	19,892	4.6%	99,972	0.7%
2024	1	78,132	1.6%	13,713	-0.4%	20,776	4.4%	100,672	0.7%
2025	2	79,352	1.6%	13,664	-0.4%	21,659	4.3%	101,371	0.7%
2026	3	80,571	1.5%	13,615	-0.4%	22,543	4.1%	102,071	0.7%
2027	4	81,790	1.5%	13,565	-0.4%	23,426	3.9%	102,770	0.7%
2028	5	83,009	1.5%	13,516	-0.4%	24,309	3.8%	103,470	0.7%
2029	6	84,228	1.5%	13,467	-0.4%	25,193	3.6%	104,169	0.7%
2030	7	85,447	1.4%	13,418	-0.4%	26,076	3.5%	104,869	0.7%
2031	8	86,666	1.4%	13,369	-0.4%	26,960	3.4%	105,569	0.7%
2032	9	87,885	1.4%	13,320	-0.4%	27,843	3.3%	106,268	0.7%
2033	10	89,104	1.4%	13,271	-0.4%	28,726	3.2%	106,968	0.7%
2034	11	90,323	1.4%	13,222	-0.4%	29,610	3.1%	107,667	0.7%
2035	12	91,543	1.3%	13,173	-0.4%	30,493	3.0%	108,367	0.6%
2036	13	92,762	1.3%	13,124	-0.4%	31,377	2.9%	109,066	0.6%
2037	14	93,981	1.3%	13,074	-0.4%	32,260	2.8%	109,766	0.6%
2038	15	95,200	1.3%	13,025	-0.4%	33,143	2.7%	110,465	0.6%
2039	16	96,419	1.3%	12,976	-0.4%	34,027	2.7%	111,165	0.6%
2040	17	97,638	1.3%	12,927	-0.4%	34,910	2.6%	111,864	0.6%
2041	18	98,857	1.2%	12,878	-0.4%	35,793	2.5%	112,564	0.6%
2042	19	100,076	1.2%	12,829	-0.4%	36,677	2.5%	113,264	0.6%
2043	20	101,295	1.2%	12,780	-0.4%	37,560	2.4%	113,963	0.6%

Calendar Year	Plan Year	Population [a]		Single Family (SF) Households [b]		Multifamily (MF) Households [b]		Employment [c]	
		Quantity	Annual Change	Quantity	Annual Change	Quantity	Annual Change	Quantity	Annual Change
2044	n/a	102,515	1.2%	12,731	-0.4%	38,444	2.4%	114,663	0.6%
2045		103,734	1.2%	12,682	-0.4%	39,327	2.3%	115,362	0.6%
2046		104,953	1.2%	12,632	-0.4%	40,210	2.2%	116,062	0.6%
2047		106,172	1.2%	12,583	-0.4%	41,094	2.2%	116,761	0.6%
2048		107,391	1.1%	12,534	-0.4%	41,977	2.1%	117,461	0.6%
2049		108,610	1.1%	12,485	-0.4%	42,861	2.1%	118,160	0.6%
2050		109,829	1.1%	12,436	-0.4%	43,744	2.1%	118,860	0.6%

[a] Population for years 2010 and 2020 were provided by the U.S. Census. Population for 2050 was calculated by assuming household occupancy of 2.5 for single family homes and 1.8 for multifamily homes. Population for intervening years was interpolated using linear growth.

[b] Number of households based on the 2050 growth preferred alternative, provided by the Redmond Planning Department.

[c] Employment estimates provided by the Puget Sound Regional Council Covered Employment Estimates by Jurisdiction.

4.2. Water Use Characteristics

The following subsections describe the City's water use characteristics since the prior planning period.

4.2.1. Production, Purchases, and Peaking Factor

Redmond purchases surface water from Cascade Water Alliance and has five of its own groundwater wells. Purchases from Cascade constitute the majority of the City's supply and this source provides all of the water delivered to Novelty Hill. As shown in Figure 4-1, for the Combined Service Area, purchases from Cascade provided 60% of the supply and Redmond's wells provided 40% of the supply for 2019-2021. This indicates the City has used more of its local groundwater supply since the prior plan when the values were 69% and 31%, respectively.

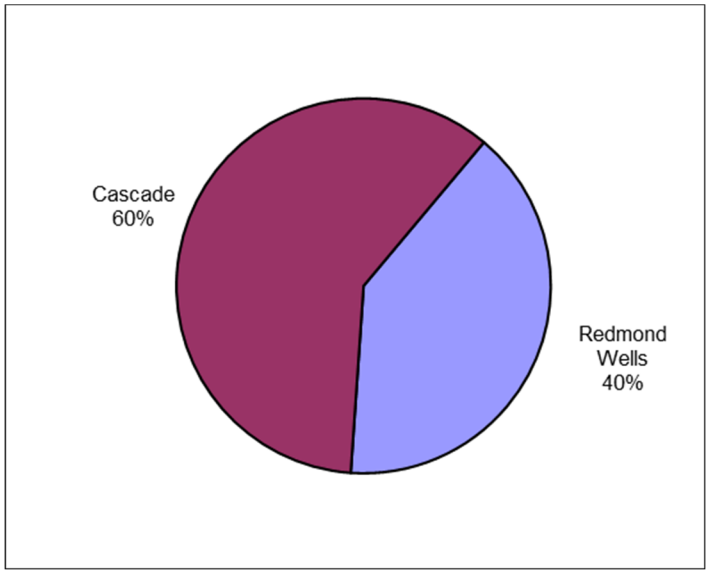

Figure 4-1. Source of supply - Combined Service Area (2019–2021)

The City Service Area uses a combination of Cascade and Redmond well water. As shown in Figure 4-2, for the City Service Area purchases from Cascade provided 55% of the supply, while the remaining balance came from Redmond's wells. The wells contributed varying volumes to the City's supply, with wells #1 and #5 providing similar volumes. Well #4 provided the least volume and was only used in the months of June – November 2020. Well #4 has ongoing water quality issues, mainly with manganese and fluctuating iron concentrations. It was also impacted by temporary construction dewatering, concerns about potential per-fluoroalkyl substances (PFAS) based on detection in surrounding monitoring wells, and low production volume relative to the water right. Therefore, Well #4 is generally not used unless necessary at this time. The City is working on solutions to address the ongoing issues with Well #4.

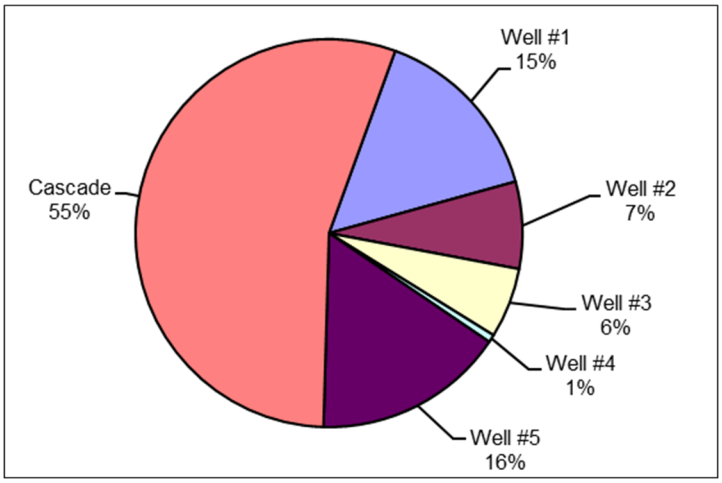

Figure 4-2. Source of supply - City Service Area (2019 – 2021)

Eight years of Redmond's water purchases and production are shown in Figure 4-3. Water production and purchases have ranged from a low of 2,477 million gallons (mg) in 2020 (the first year of the COVID-19 pandemic) to a high of 2,770 mg in 2015 (significant drought year). The 2019-2021 average purchases and production from each source are provided in Table 4-2. Total purchases and production averaged 2,548 mg for 2019-2021. This production profile suggests demands were stable throughout the planning period despite growth in population and connections to the system. This is common in the Northwest and is the result of water conservation programs and an increasingly water-conscious population.

Purchases and production by month for 2019-2021 are shown in Figure 4-4. As with most water utilities, Redmond's purchases and production increase in the summer months due to outdoor water use, primarily irrigation.

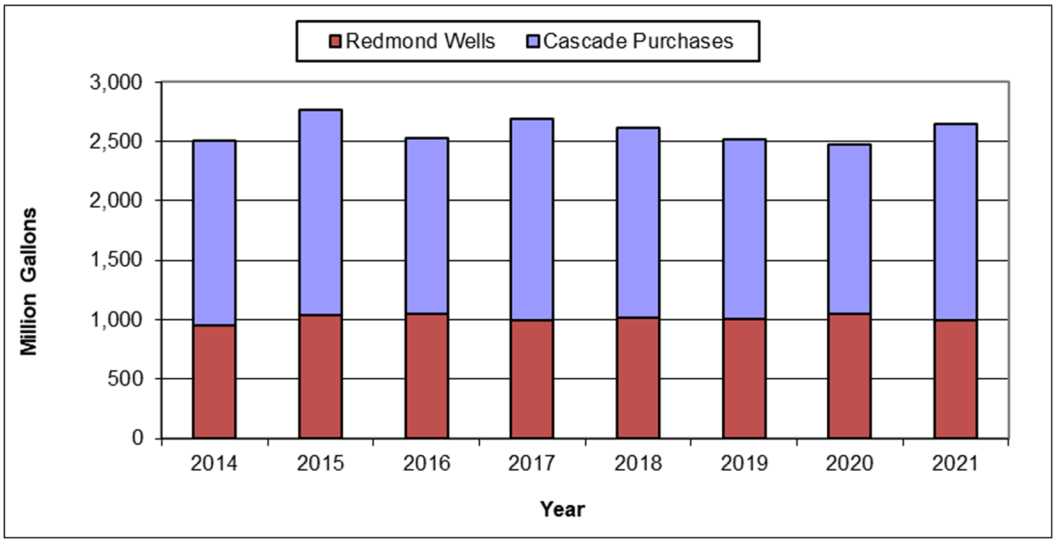

Figure 4-3. Annual water purchases and production for the Combined Service Area (2014–2021)

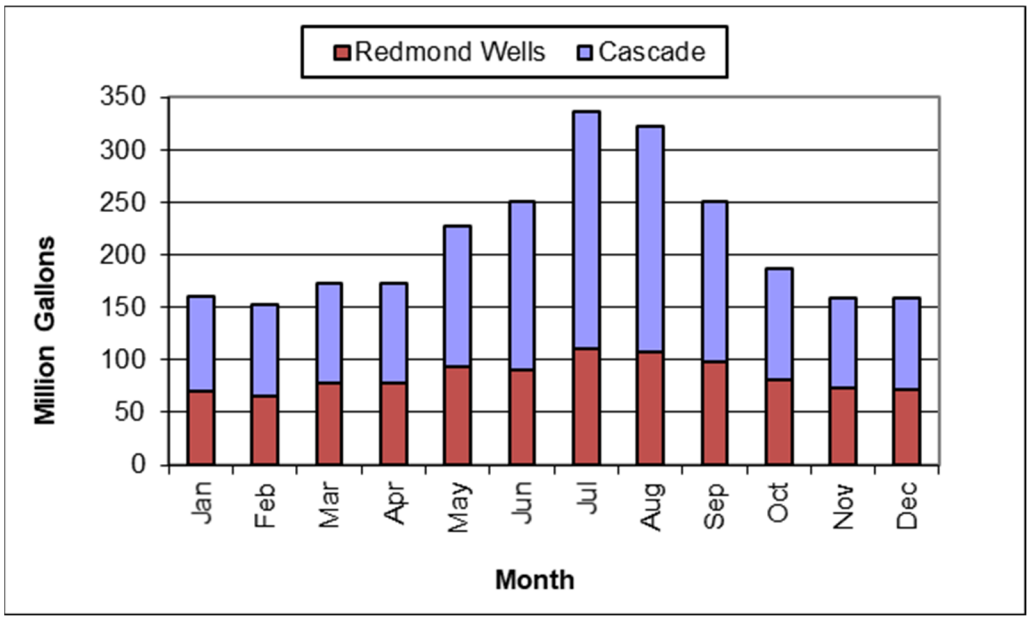

Figure 4-4. Monthly distribution of water purchases and production for the Combined Service Area (2019–2021 Average)

Table 4-2. 2019-2021 Average water purchases and production (million gallons)

Month	City Service Area								Novelty Hill Service Area		Combined Service Area			
	Well #1	Well #2	Well #3	Well #4	Well #5	Cascade	Subtotal	Percent	Cascade	Percent	Redmond Wells	Cascade	Total	Percent
Jan	24	13	8	0	25	75	146	6%	15	5%	71	90	161	6%
Feb	22	12	9	0	23	73	138	6%	15	5%	66	87	153	6%
Mar	25	13	12	0	27	77	154	7%	18	7%	77	95	173	7%
Apr	26	13	13	0	27	78	156	7%	16	6%	79	94	172	7%
May	31	15	14	0	33	110	203	9%	23	8%	94	133	227	9%
Jun	30	14	12	2	32	129	219	10%	32	11%	90	160	251	10%
Jul	38	17	14	1	41	184	295	13%	41	15%	111	225	336	13%
Aug	36	16	12	4	39	172	279	12%	42	15%	107	214	322	13%
Sep	33	14	11	4	36	123	222	10%	28	10%	98	152	250	10%
Oct	28	12	8	3	30	89	170	7%	17	6%	81	105	187	7%
Nov	25	12	8	1	26	68	141	6%	17	6%	73	85	158	6%
Dec	25	12	10	0	25	74	145	6%	14	5%	71	88	159	6%
Total	**344**	**164**	**133**	**15**	**363**	**1,251**	**2,270**	**100%**	**279**	**100%**	**1,019**	**1,529**	**2,548**	**100%**
Percent	**15%**	**7%**	**6%**	**1%**	**16%**	**55%**	**100%**	**n/a**	**100%**	**n/a**	**40%**	**60%**	**100%**	**n/a**

Average day demands (ADD) were calculated by dividing the total production and purchases in a year by the number of days in that year. Peak day demands, or maximum day demands (MDD), were developed from SCADA data by searching for maximum combined flow on all well booster pumps and intertie stations. Peaking factors (MDD divided by ADD) for 2014 to 2021 are shown in Table 4-3. The peaking factor has ranged from 2.3 in 2021 to 3.2 in 2017. The average peaking factor for 2019 – 2021 was 2.6, which was used in the demand forecast and system capacity analyses.

Table 4-3. Average day demands, maximum day demands, and peaking factors, 2014 - 2021

Year	Average Day (mgd) [a]	Peak Day [b]		Peaking Factor
		(mgd)	Date	
2014	6.9	16.9	7/12/2014	2.5
2015	7.6	17.7	7/10/2015	2.3
2016	6.9	16.3	8/1/2016	2.4
2017	7.4	23.4	8/30/2017	3.2
2018	7.2	18.1	7/14/2018	2.5
2019	6.9	20.9	6/15/2019	3.0
2020	6.8	16.0	7/31/2020	2.4
2021	7.2	16.7	7/2/2021	2.3
2019-2021 Avg	7.0	17.9	n/a	2.6

[a] Data Source: "Wells 1-5" PDF data provided by City staff.

[b] Data Source: "Max Day Production" spreadsheet provided by City staff.

4.2.2. Customer Categories, Connections, and Consumption

Redmond has the following five customer categories:

- **Single Family (Residential):** Detached residential buildings serving a single family, accessory dwelling units, and common-wall multifamily units with individual meters for each unit.
- **Multifamily:** Residential buildings, such as apartment buildings, duplexes, or condos, that serve multiple households.
- **Commercial (Non-Residential):** All non-residential customers. This category includes two subcategories in addition to regular commercial demands:
    - **Irrigation:** Irrigation water provided through a dedicated irrigation line. These customers represent the full range of customer types including single family, multifamily, and non-residential. Note that irrigation water may also be provided through the other customer categories when there is no dedicated irrigation line, particularly for single family residential.
    - **Fire:** Single-family residential fire sprinklers. While these meters are associated with single-family residences, they are considered non-residential connections to segregate fire consumption from other domestic consumption used to determine water use factors.

The number of customer connections by category from 2008 to 2021 is provided in Table 4-4. At the end of 2021, the Combined Service Area had 19,581 connections, the vast majority of which (80%) were single family. The proportion of customer types differs between the City Service Area and the Novelty Hill Service Area. The City Service Area has a sizable portion of multifamily and non-residential connections. The Novelty Hill Service Area is predominately single family connections, though multifamily and non-residential growth has occurred since the prior plan.

Table 4-4. Number of connections by customer class, 2008 – 2021 [a,b,c]

Year		City Service Area						Novelty Hill Service Area						Combined Service Area					
		Single Family	Multifamily	Non-Residential	Irrigation	Fire	Subtotal	Single Family	Multifamily	Non-Residential	Irrigation	Fire	Subtotal	Single Family	Multifamily	Non-Residential	Irrigation	Fire	Subtotal
2008		10,845	1,294	1,280	510	352	14,281	2,436	80	55	50	4	2,625	13,281	1,374	1,335	560	356	16,906
2009		10,897	1,296	1,300	520	457	14,470	2,520	80	57	53	4	2,714	13,417	1,376	1,357	573	461	17,184
2010		11,016	1,297	1,293	525	523	14,654	2,700	80	57	56	4	2,897	13,716	1,377	1,350	581	527	17,551
2011		11,124	1,301	1,297	526	558	14,806	2,863	80	57	59	4	3,063	13,987	1,381	1,354	585	562	17,869
2012		11,194	1,320	1,296	531	568	14,909	3,025	80	57	58	4	3,224	14,219	1,400	1,353	589	572	18,133
2013		11,362	1,325	1,248	536	578	15,049	3,172	80	57	60	4	3,373	14,534	1,405	1,305	596	582	18,422
2014		11,525	1,327	1,251	545	578	15,226	3,246	80	57	63	4	3,450	14,771	1,407	1,308	608	582	18,676
2015		11,688	1,330	1,250	554	570	15,392	3,297	80	61	63	4	3,505	14,985	1,410	1,311	617	574	18,897
2016		11,811	1,331	1,255	559	570	15,526	3,297	80	61	63	4	3,505	15,108	1,411	1,316	622	574	19,031
2017		11,966	1,335	1,252	561	570	15,684	3,296	80	64	63	4	3,507	15,262	1,415	1,316	624	574	19,191
2018		12,095	1,337	1,248	574	570	15,824	3,296	80	80	64	4	3,524	15,391	1,417	1,328	638	574	19,348
2019		12,203	1,347	1,234	569	570	15,923	3,296	80	81	65	4	3,526	15,499	1,427	1,315	634	574	19,449
2020		12,285	1,318	1,262	575	570	16,010	3,296	80	82	66	4	3,528	15,581	1,398	1,344	641	574	19,538
2021		12,331	1,316	1,255	579	570	16,051	3,296	80	85	65	4	3,530	15,627	1,396	1,340	644	574	19,581
2019-2021 Avg [d]	**#**	**12,273**	**1,327**	**1,250**	**574**	**570**	**15,995**	**3,296**	**80**	**73**	**64**	**4**	**3,518**	**15,350**	**1,411**	**1,324**	**631**	**574**	**19,291**
	%	**77%**	**8%**	**8%**	**4%**	**4%**	**100%**	**94%**	**2%**	**2%**	**2%**	**0.1%**	**100%**	**80%**	**7%**	**7%**	**3%**	**3%**	**100%**

[a] Data Source: Number of Connections By Class excel spreadsheets

[b] Categories in the raw data are commercial, irrigation, multifamily, residential, townhomes, and multiuse. Within those categories, service codes are applied which describe meters associated with more precise uses such as irrigation and fire. Those meters were isolated to determine the final number of meters that belong in the irrigation and fire categories. Multiuse meters were considered non-residential.

[c] Townhomes go into single family residential category

[d] Average number of connections is used to calculate the proportions of connections in each service area.

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Water consumption data were provided by the City's billing department. Billing data was made available as monthly totals for the entire system by customer class and included a line item for water wheeled to Sammamish Plateau Water (Sammamish). Consumption data included an additional "Exempt" category describing connections that are not charged for sewer based on use of this meter. These connections are all non-residential. The City provided data describing the proportion of water billed in the City Service Area vs. the Novelty Hill service area; the proportions average approximately 89% and 11%, respectively, throughout the period of record. These are the values the City reports to Cascade.

The average water billings, by customer category and by month, over the last 3 years is provided in Table 4-5. The monthly distribution of actual water differs from this representation since billing numbers are based on meter read dates, which are not perfectly aligned with the month.

Consumption by service area is shown in Figure 4-5. Approximately 89% of the consumption occurs in the City Service Area, 11% in the Novelty Hill Service Area, and less than 1% is wheeled to Sammamish. The consumption by customer category in the City and Novelty Hill service areas is shown in Figure 4-6 and Figure 4-7, respectively. The Fire and Sammamish customer categories do not appear on these figures because their relative proportions are much smaller than all other customer classes (less than 1%).

In the City Service Area, single family represents approximately one third of total consumption at 34%, with multifamily and non-residential demands following behind at 31% and 19%, respectively. Irrigation accounts for 13% of demands, with a majority of the remaining demands in the exempt category and a very small proportion for fire. In the Novelty Hill service area, a significantly greater proportion of consumption is in the single family category at 70%. The multifamily category comprises 12% of consumption, with the remaining categories each comprising less than 10%.

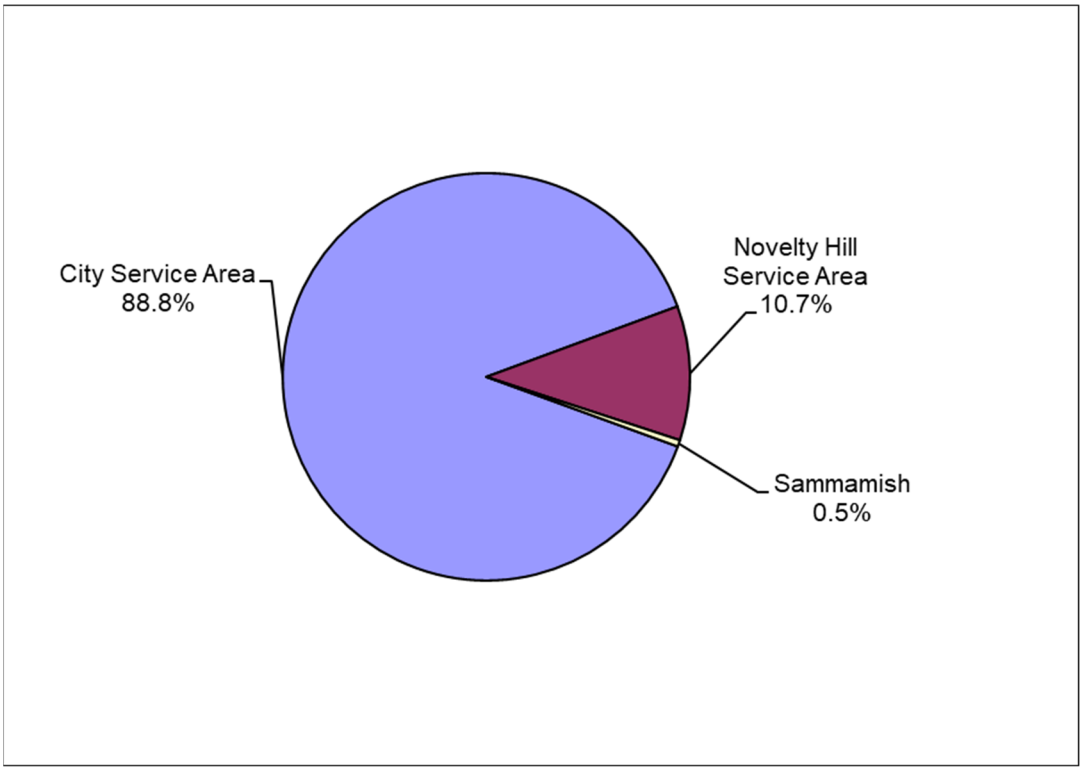

Figure 4-5. Consumption by service area (2019–2021)

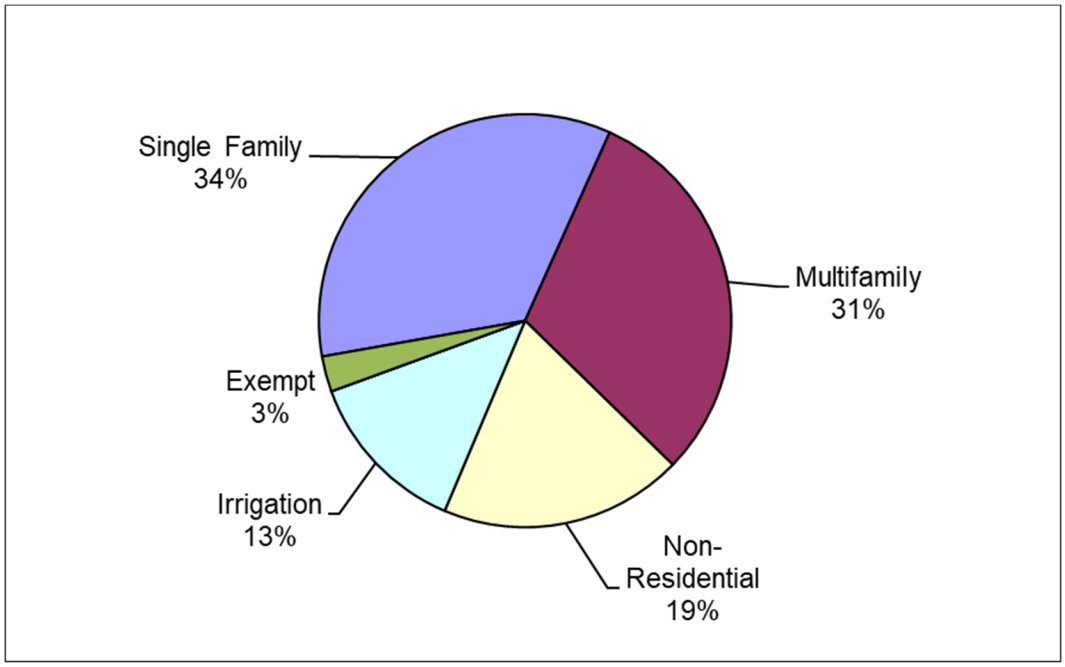

Figure 4-6. Consumption in the City Service Area by customer category (2019–2021)

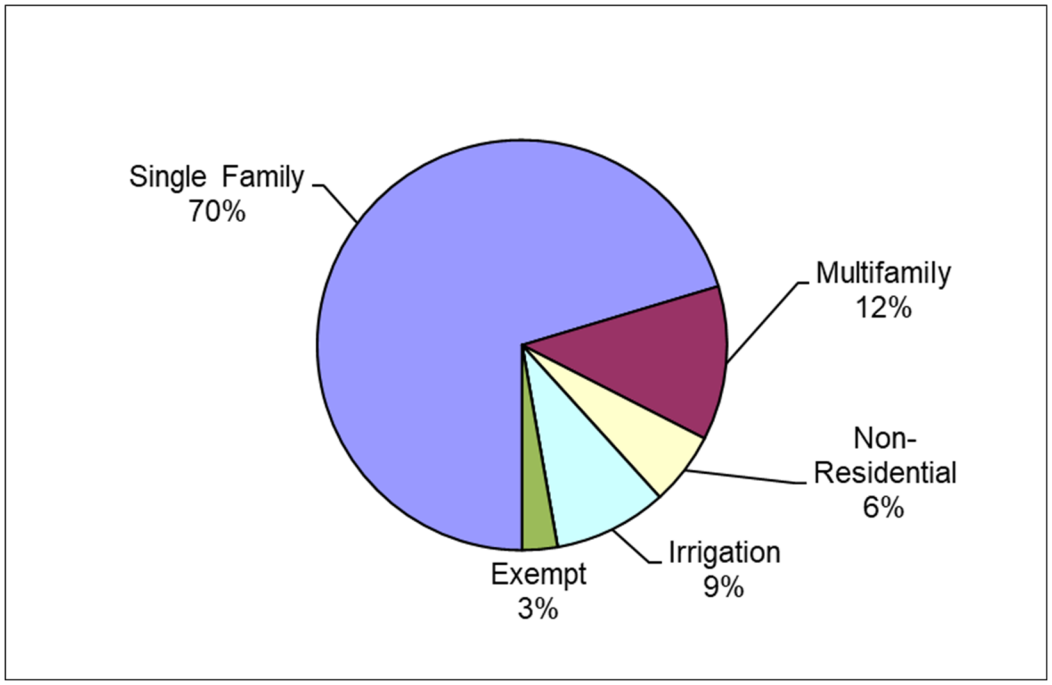

Figure 4-7. Consumption in the Novelty Hill Service Area by customer category (2019–2021)

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Table 4-5. Average water consumption in million gallons, 2019 – 2021 [a,b,c]

Month	Retail																								
	City Service Area								Novelty Hill Service Area									Combined Service Area							
	Single Family	Multi family	Non-Residential	Irrigation	Fire[d]	Exempt	Sub total	Percent	Single Family[e]	Multi family	Non-Residential	Irrigation	Fire	Exempt	Sammamish	Sub total	Percent	Single Family	Multi family	Non-Residential	Irrigation	Fire	Exempt	Sammamish	TOTAL	Percent
Jan	45.4	51.3	27.9	0.7	0.0	0.2	125.4	6%	12.4	2.5	1.1	0.1	0.0	0.0	0.4	16.5	6%	57.8	53.8	29.0	0.7	0.0	0.2	0.4	141.9	6%
Feb	48.1	47.1	29.8	0.5	0.0	0.2	125.7	6%	11.8	2.7	1.3	0.0	0.0	0.0	0.3	16.1	6%	59.9	49.8	31.1	0.5	0.0	0.2	0.3	141.8	6%
Mar	49.6	53.0	31.5	1.3	0.0	0.5	135.8	7%	11.8	2.4	1.2	0.1	0.0	0.1	0.3	15.9	6%	61.4	55.3	32.7	1.4	0.0	0.5	0.3	151.6	6%
Apr	59.9	52.0	28.0	6.7	0.0	1.5	148.1	7%	10.8	2.4	1.1	0.5	0.0	0.2	5.5	20.5	8%	70.7	54.4	29.1	7.3	0.0	1.7	5.5	168.6	7%
May	49.9	54.4	32.8	27.2	0.0	5.3	169.6	8%	10.8	2.6	1.2	2.3	0.0	0.6	0.8	18.3	7%	60.7	57.0	34.0	29.4	0.0	6.0	0.8	188.0	8%
Jun	85.9	53.7	36.4	47.3	0.0	9.4	232.8	11%	12.2	2.5	1.1	3.9	0.0	1.1	0.7	21.4	8%	98.1	56.2	37.5	51.3	0.0	10.6	0.7	254.3	11%
Jul	85.1	56.3	42.2	67.9	0.0	13.0	264.5	13%	12.3	2.6	1.1	5.6	0.0	1.6	1.1	24.1	9%	97.4	58.9	43.3	73.5	0.0	14.5	1.1	288.7	12%
Aug	92.0	56.5	44.1	68.7	0.0	14.7	276.1	13%	19.0	2.6	1.2	5.6	0.0	1.8	1.1	31.4	12%	111.0	59.1	45.4	74.3	0.0	16.5	1.1	307.5	13%
Sep	62.3	53.9	37.7	42.2	0.0	10.2	206.3	10%	19.0	2.6	1.5	3.4	0.0	1.2	0.6	28.3	11%	81.3	56.6	39.2	45.6	0.0	11.4	0.6	234.6	10%
Oct	51.2	54.1	32.3	8.0	0.0	2.4	147.8	7%	21.7	2.7	1.4	0.6	0.0	0.3	0.4	27.1	10%	72.9	56.7	33.7	8.6	0.0	2.6	0.4	175.0	7%
Nov	36.7	51.7	28.4	1.2	0.0	0.4	118.4	6%	21.6	2.5	1.2	0.1	0.0	0.0	0.5	25.9	10%	58.3	54.2	29.6	1.3	0.0	0.4	0.5	144.4	6%
Dec	52.8	52.1	26.5	0.4	0.0	0.2	132.0	6%	12.4	2.5	1.1	0.0	0.0	0.0	0.6	16.7	6%	65.2	54.7	27.6	0.4	0.0	0.2	0.6	148.7	6%
Total	**718.8**	**636.3**	**397.7**	**272.0**	**0.0**	**57.9**	**2,082.6**	**100%**	**175.9**	**30.4**	**14.4**	**22.4**	**0.0**	**6.9**	**12.3**	**262.2**	**100%**	**894.6**	**666.7**	**412.0**	**294.4**	**0.0**	**64.8**	**12.3**	**2,344.9**	**100%**
Percent	**35%**	**31%**	**19%**	**13%**	**0%**	**3%**	**100%**	**n/a**	**67%**	**12%**	**5%**	**9%**	**0%**	**3%**	**5%**	**100%**	**n/a**	**38%**	**28%**	**18%**	**13%**	**0%**	**3%**	**1%**	**100%**	**n/a**

[a] Data Source: "Water Sold by Month" and "UBCons" spreadsheets provided by City staff.

[b] Eight years of billing data was analyzed; however the average uses the most recent three years in order to focus on current trends.

[c] The monthly distribution of actual water use may differ somewhat from this representation since billing numbers are based on meter read dates and some meters are read bi-monthly.

[d] Fire consumption is on the scale of hundreds of cubic feet. The minimum consumption observed was 200 cubic feet in numerous months between 2019 – 2021, and the maximum was 1,800 cubic feet in December 2021. When converted to million gallons per month, the values round to 0.0.

[e] The bi-monthly billings of the Novelty Hill Service Area single family customers showed minimal sales one month and large sales the next month. Therefore, the billings were smoothed out over each two month period.

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Monthly distribution of water billings is shown in Figures 3-8 to 3-10 for the City Service Area, the Novelty Hill Service Area, and Sammamish wholesale, respectively. As noted previously, the monthly distribution of actual water use may differ somewhat from this representation since billing numbers are based on meter read dates, which lag behind actual use. As shown in Figure 4-8 and Figure 4-9, the City and the Novelty Hill Service Areas both show increased use in the summer due to outdoor water use driven by the single family, irrigation, and exempt customer categories. The customer classes associated with irrigation demands are described in greater detail in section 3.2.4. Figure 4-10 displays the average water sold to Sammamish from 2019 – 2021. Historical data suggests there is no seasonal pattern that dominates the monthly volume of water wheeled to Sammamish. The large April volume is due to a significantly larger than normal volume sold to Sammamish in April 2021.

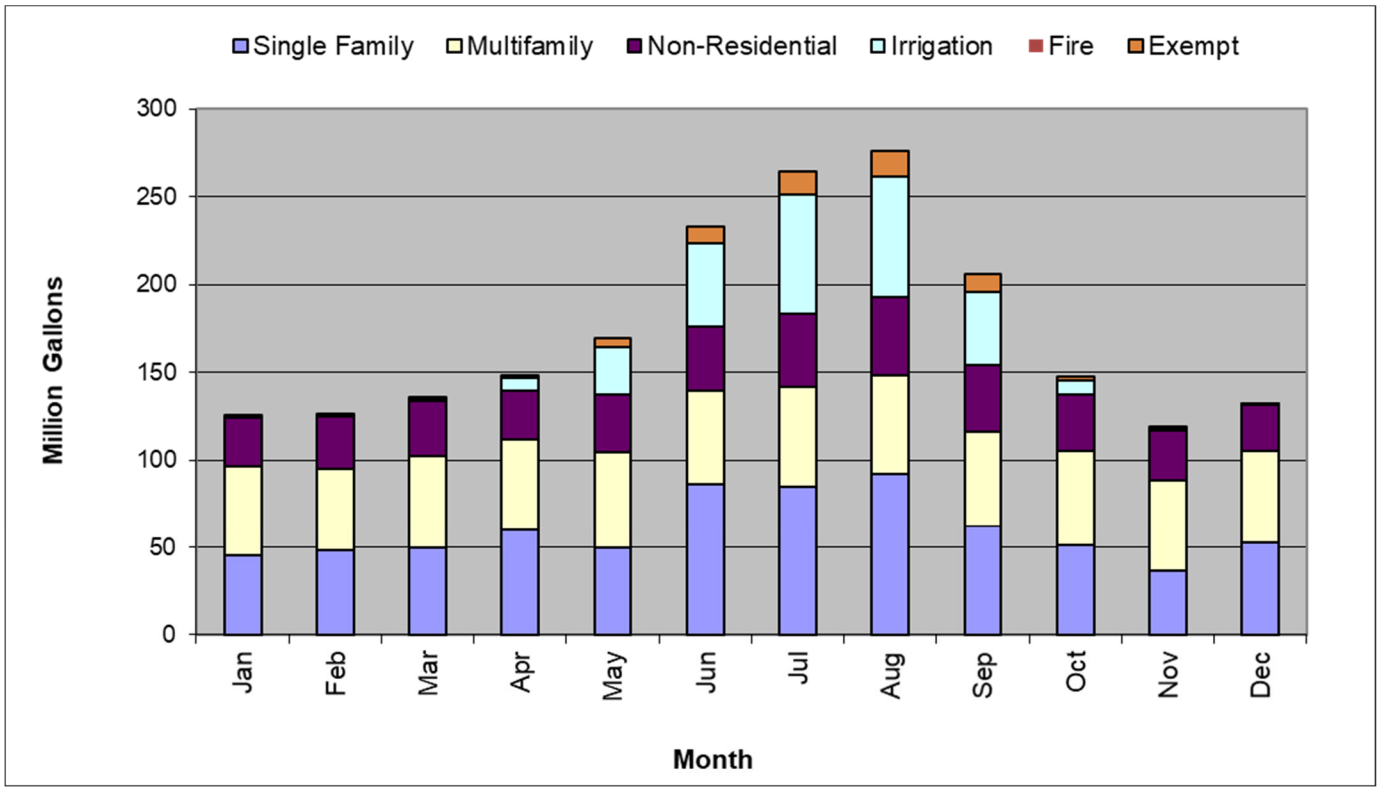

Figure 4-8. Monthly distribution of water consumption in City Service Area (2019–2021 Average)

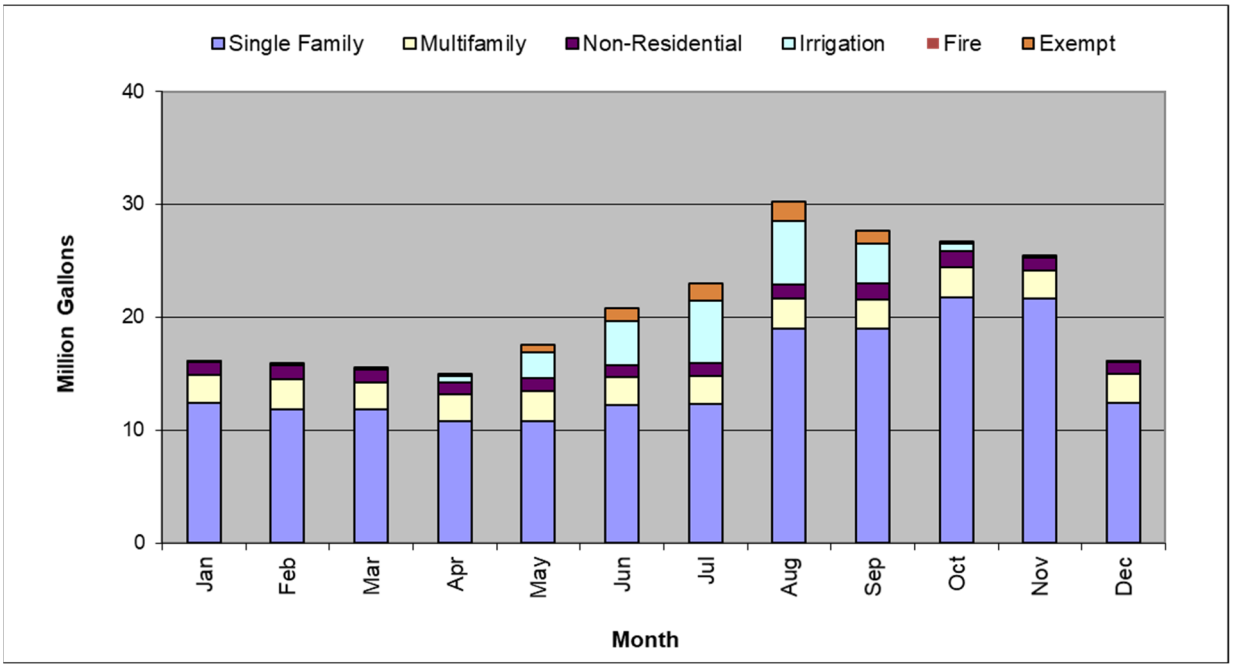

Figure 4-9. Monthly distribution of water consumption in Novelty Hill Service Area (2019–2021 Average)

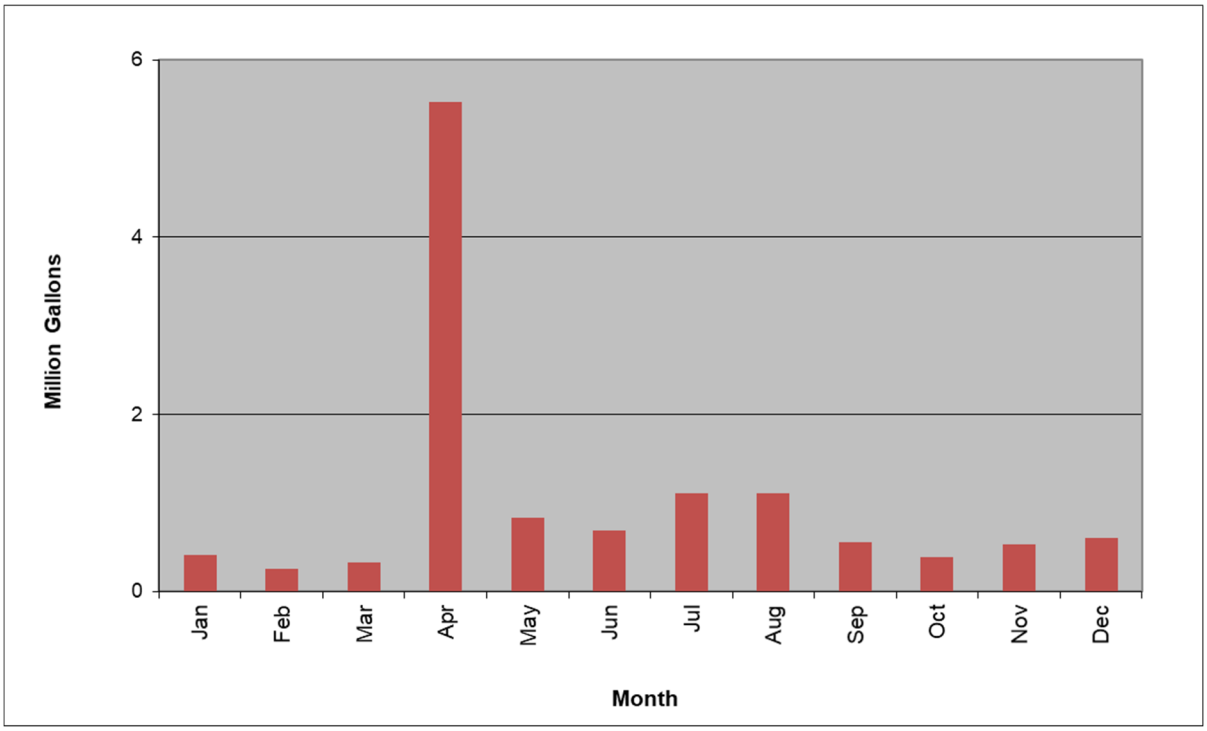

Figure 4-10. Monthly distribution of water consumption for Sammamish (2019–2021 Average)

Customers with large water demands are of interest because their demand could have significant impact on the overall demand for Redmond. The 10 largest customers, in terms of water consumption, were examined for 2016 to 2021. Table 4-6 shows the 10 largest customers for 2021; the large customer profile changes year to year, so a single year is shown to simplify and represent a general profile of large users. In 2021, the 10 largest customers had a combined annual consumption of 367 mg, which was 14% of the 2021 production and purchases.

Table 4-6. Largest 10 customers in 2021

#	Name	Billing Category	Annual Consumption (mg)
1	MICROSOFT	Commercial	135
2	CITY OF REDMOND	Commercial/Irrigation	31
3	SIXTY-01 APARTMENT COMPLEX	Multifamily	30
4	ESSEX REDMOND HILL NE LP	Multifamily	29
5	SASADA SPORTS INTERNATIONAL	Irrigation	26
6	UNISEA INC	Commercial	25
7	ESSEX REDMOND HILL CWLP	Multifamily	24
8	DIG-KW REDMOND LLC	Multifamily	23
9	CAMBRIAN APARTMENTS 04WA009	Multifamily	22
10	KING COUNTY PARKS/MARYMOOR	Irrigation	20
		Total:	367

4.2.3. Water Balance, Non-Revenue, and Leakage

A water balance is an accounting for all water that is produced and purchased. Redmond's 2021 water balance is shown in Table 4-7. The table is a slightly modified version of the format recommended for use by the American Water Works Association.

The water balance allocates the Water Produced and Purchased to different categories at three different levels.

Level 1 allocates the water to either Revenue Water or Non-Revenue Water. As implied by the names, Revenue Water generates income while Non-Revenue Water does not. This is helpful in understanding what percent of water production and purchases generates income for Redmond. Additionally, non-revenue water needs to be factored into the demand forecast. Redmond's 2021 water production and purchases are divided into 92.3% Revenue Water and 7.7% Non-Revenue Water.

Table 4-7. Water balance (2021)

	Level 1	Level 2	Level 3	Volume (mg)		% of Produced and Purchased Water
Water Produced and/or Purchased	Revenue Water	Billed Authorized Consumption	1. Billed Water Exported	24	[a]	0.9%
			2. Billed Metered Consumption	2,420	[b]	91.4%
			3. Billed Unmetered Consumption	0	[c]	0%
	Non-Revenue Water	Unbilled Authorized Consumption	4. Unbilled Metered Consumption	0	[d]	0%
			5. Unbilled Unmetered Consumption	0	[d]	0%
		Apparent Losses	6. Unauthorized Consumption	0	[d]	0%
			7. Customer Metering Inaccuracies	0	[d]	0%
		Real Losses	8. Known Leakage	0	[d]	0%
			9. Assumed Leakage	203	[e]	7.7%
			TOTAL	**2,646**	[f]	**100%**

[a] Data Source: "2021 Water Sold by Month" spreadsheet provided by City staff. This is water provided to Sammamish.
[b] Data Source: "2021 Water Sold by Month" spreadsheet provided by City staff.
[c] This category does not apply to Redmond.
[d] Redmond staff do not track this number, therefore zero was used in the water balance.
[e] Water Production minus all other categories.
[f] Data Source: Well production and Cascade purchases spreadsheets provided by City staff.

Level 2 splits Non-Revenue Water into the following three sub-categories, which are useful in identifying potential additional revenue sources and identifying the magnitude of leaks or other losses that could be addressed:

- **Unbilled Authorized Consumption:** Includes uses such as water system flushing, firefighting, and unbilled contractor use. Typically, it is standard practice not to charge for uses falling into this sub-category. However, it is always a prudent idea to review these uses to ensure that a legitimate revenue opportunity is not missed.
- **Apparent Losses:** Includes unauthorized uses and customer meter inaccuracies, both of which are lost revenue opportunities.
- **Real Losses:** Includes various types of system leaks. A certain level of leakage is unavoidable; however, leakage beyond that level should be repaired to avoid unduly burdening both the natural resource and the physical infrastructure. Any amount that cannot be assigned to another category is considered a real loss under the American Water Works Association's protocol, as well as per the formula for calculating distribution system leakage under Washington State's Water Use Efficiency Rule.

Redmond did not provide data regarding authorized non-revenue water. Therefore, all non-revenue water is considered distribution system leakage.

Level 3 further splits water into additional sub-categories to support further estimation and water management.

A longer history of other water balance elements is provided in Table 4-8. The table contains data from 2014 to 2021. The 2019–2021 average distribution system leakage has been 8.0% of water production and purchases. Under Washington State's Water Use Efficiency Rule, distribution system leakage should not exceed 10%, based on a 3-year rolling average. Redmond has achieved this goal since 2015.

The 2019–2021 average non-revenue water as a percent of consumption is 8.7%. This number is used to develop the non-revenue component of the demand forecast.

Table 4-8. Distribution system leakage

Year	Water Produced and Purchased [a]	Authorized Consumption [b]	Distribution System Leakage [c]		
			Qty	Percent of Production & Purchases	Percent of Consumption [d]
2014	2,508	2,209	298	11.9%	13.5%
2015	2,770	2,606	164	5.9%	6.3%
2016	2,534	2,403	132	5.2%	5.5%
2017	2,696	2,506	190	7.0%	7.6%
2018	2,620	2,451	169	6.4%	6.9%
2019	2,522	2,350	173	6.8%	7.4%
2020	2,477	2,265	212	8.5%	9.3%
2021	2,646	2,420	226	8.6%	9.4%
2019-2021 Average [e]	**2,548**	**2,345**	**204**	**8.0%**	**8.7%**

[a] Data Source: "Redmond Water Usage" spreadsheets provided by City staff.

[b] Data Source: "WSP 10 Year Water Consumption" spreadsheet provided by City staff.

[c] Distribution system leakage is defined in the new Water Use Efficiency Rule as water production and purchases minus authorized consumption.

[d] Used for developing the demand forecast. Note this is intentionally different than non-revenue as a percent of production and purchases.

[e] Five years of data was analyzed, however the average uses the most recent three years in order to focus on current trends.

4.2.4. Water Use Factors and Equivalent Residential Units

Water use factors were calculated for three customer categories: single family, multifamily, and non-residential. The water for the irrigation customer category was allocated to the single family, multifamily, and non-residential categories to better estimate the impact outdoor use has on the water use factors. As described in Table 4-4, most meters have both a category (i.e., customer class) and a service code. The service code may indicate that while a meter is in the single-family customer class, its service code is for irrigation, meaning it provides irrigation water for single family households. This situation appears for all customer categories. Therefore, the

relative proportions of consumption through irrigation service code meters by customer class were used to allocate the consumption of those irrigation meters without a clear connection to a customer class to better estimate the impact irrigation use has on water use factors. Table 4-9 displays the irrigation reallocation calculation for the City Service Area. In the City Service Area, 70% of the irrigation category was allocated to the multifamily class and 30% was allocated to the non-residential class. The City assumed the same percent split applied to the Novelty Hill Service Area.

Table 4-9. Irrigation reallocation for the City Service Area

2019		
Original Numbers[1]		
%	Cf	Sector
0.000%	100	SF
18%	5,735,100	MF
43%	13,582,200	NR
39%	12,397,500	Irrigation
100%	31,714,900	Total
MF and NR[2]		
%	Cf	Sector
30%	5,735,100	MF
70%	13,582,200	NR
100%	19,317,300	Total
Allocate Irrigation to Other Sectors[3]		
%	Cf	Sector
0.000%	100	SF
30%	9,415,785	MF
70%	22,299,015	NR
0%	0	Irrigation
100%	31,714,900	Total

2020		
Original Numbers[1]		
%	Cf	Sector
0.001%	300	SF
19%	5,678,700	MF
46%	13,713,500	NR
35%	10,622,000	Irrigation
100%	30,014,500	Total
MF and NR[2]		
%	Cf	Sector
29%	5,678,700	MF
71%	13,713,500	NR
100%	19,392,200	Total
Allocate Irrigation to Other Sectors[3]		
%	Cf	Sector
0.001%	300	SF
29%	8,789,185	MF
71%	21,225,015	NR
0%	0	Irrigation
100%	30,014,500	Total

2021		
Original Numbers[1]		
%	Cf	Sector
0.0215%	8,800	SF
20%	8,200,700	MF
45%	18,560,200	NR
34%	14,088,000	Irrigation
100%	40,857,700	Total
MF and NR[2]		
%	Cf	Sector
31%	8,200,700	MF
69%	18,560,200	NR
100%	26,760,900	Total
Allocate Irrigation to Other Sectors[3]		
%	Cf	Sector
0.0215%	8,800	SF
31%	12,517,874	MF
69%	28,331,026	NR
0%	0	Irrigation
100%	40,857,700	Total

2019-2021 Avg		
Allocate Irrigation to Other Sectors[3]		
%	Cf	Sector
0.008%		SF
30%		MF
70%		NR
0%		Irrigation
100%		Total

[1] Allocated the consumption from irrigation and exempt meters to SF, MF, NR & Irrigation based on consumption data in the Springbrook data set.. Some meters had sufficient information to determine that the water is for the SF, MF, or NR sector. If the meter did not have sufficient information, the water was allocated to Irrigation.

[2] Relative weighting of MF and NR.

[3] Allocated the water in the "Irrigation" category to MF and NR, based on the ratio of the original MF and NR numbers.

Table 4-10 shows the inputs and the results of the water use factor calculations. For the single-family category, the water use factor is 160, 146, and 157 gallons per day (gpd) per single family household respectively for the City, the Novelty Hill, and the Combined Service Areas. For the multifamily category, the water use factor is 131, 116, and 131 gpd per multifamily household respectively for the City, the Novelty Hill, and the Combined Service Areas. For the non-residential category, the water use factor is 17 gpd per employee in the City Service Area. An employee-based non-residential water use factor was not developed for the Novelty Hill Service Area since it was not required for the demand forecasting method applied to that area. These water use factors are inclusive of the irrigation demand allocations described previously.

Table 4-10. Water use factors and ERUs (2019-2021 average)

Customer Category	City Service Area					
	Consumption (gpd)	Households or Employees		Consumption Per Household or Employee (gpd)		Number of ERUs [h]
Single Family (SF) [a]	1,969,251	12,273	[d]	160	[g]	12,273
Multifamily (MF) [b]	1,965,777	14,961	[e]	131		12,286
Non Residential (NR) [c]	1,612,100	96,839	[f]	17		10,076
	Novelty Hill Service Area					
	Consumption (gpd)	Households or Employees		Consumption Per Household or Employee (gpd)		Number of ERUs
Single Family (SF) [a]	481,845	3,296	[d]	146	[g]	3,296
Multifamily (MF) [b]	101,662	873	[e]	116		696
Non Residential (NR) [c]	82,315	n/a	[i]	n/a	[i]	564
	Combined Service Area					
	Consumption (gpd)	Households or Employees		Consumption Per Household or Employee (gpd)		Number of ERUs
Single Family (SF)	2,451,096	15,569	[d]	157	[g]	15,569
Multifamily (MF)	2,067,439	15,834	[e]	131		13,168
Non Residential (NR)	1,694,414	n/a	[i]	n/a	[i]	10,792

[a] For consumption, this includes the "residential" category, plus a portion of the "irrigation" category. For the City and Novelty Hill service areas, the portion of irrigation water is small enough to round to 0%.

[b] For consumption, this includes the "multifamily" category, plus a portion of the "irrigation" category. This includes 30% of the irrigation water.

[c] For consumption, this includes the "commercial" category, plus a portion of the "irrigation" category. This includes 70% of the irrigation water.

[d] Data Source: Number of connections by class spreadsheets provided by City staff.

[e] Data Source: “MF_Equiv_Dwell Units” spreadsheets provided by City staff.

[f] Data Source: City of Redmond's Planning and Community Development Department. Note this is the 2019-2021 average.

[g] This number is the City of Redmond's ERU. ERUs, or equivalent residential units, are a method of representing water use by non-residential customers as an equivalent number of residential customers. The City's ERU is the average amount of water used by a single family household. The ERU is calculated by dividing single family water consumption by the number of single family households.

[h] The number of ERUs in any customer category is calculated by dividing that customer category's water consumption by the ERU value (i.e., the consumption per single family household).

[i] The number of employees in Novelty Hill is unknown.

Table 4-10 also shows the number of Equivalent Residential Units, or ERUs, in each customer category. ERUs are a method of representing water use by non-residential customers as an equivalent number of residential customers. An ERU is the amount of water used by a single family household. For the Combined Service Area, Redmond's ERU number is 157 gpd. This is reduced from the ERU value in the prior WSP which was 176 gpd. This is due to a nearly 3,000 increase in single family connections but with only a mild increase in single family consumption. For the Combined Service Area, the number of ERUs for each customer category is obtained by dividing the consumption for a customer category by 157. For the Combined Service Area, the 2019-2021 average number of ERUs was 39,529. This is greater than the total combined ERUs in the prior plan of 36,694. The single family and multifamily customer classes are the primary reasons for this increase.

4.3. Demand Forecast

4.3.1. Demand Forecast Methodology

Different demand forecast methodologies were used for the City Service Area, the Novelty Hill Service Area, and for the water wheeled to Sammamish.

City Service Area

For the City Service Area, the demand forecast methodology is shown graphically in Figure 4-11. The basic process is to combine demographic data with water use factors to develop the retail demands. Demands are also developed for non-revenue water. The retail and the non-revenue demands are summed to create the total average day demand. To generate the total maximum day demand, a peaking factor is applied to the average day demand. More details on each step are provided below.

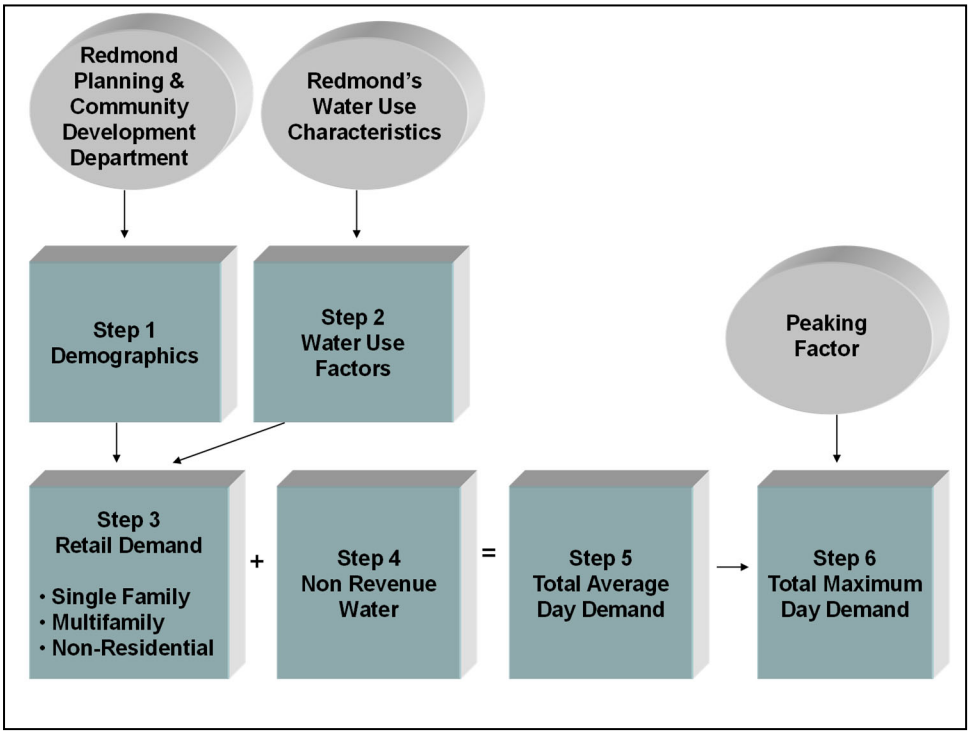

Figure 4-11. Demand forecast methodology for City Service Area

- **Step 1 Demographics:** Demographics were developed per the methodology described in Section 3.1.
- **Step 2 Water Use Factors:** Water use factors were developed per the methodology described in Section 3.2.4.
- **Step 3 Retail Demand:** The demographic projections (from Step 1) were multiplied by the water use factors (from Step 2) to generate the demand for the single family, multifamily, and non-residential customer categories.
- **Step 4 Non-Revenue Demand:** The sum of all retail demands (single family, multifamily, and non-residential) was multiplied by the 2019–2021 average "non-revenue water as % of consumption" from the water balance table, which is 8.7%.
- Step 5 Total Average Day Demand (ADD): The average day demand was calculated by adding the demands from all preceding steps.
- **Step 6 Total Maximum Day Demand (MDD):** To generate the total maximum day demand, a peaking factor was applied to the average day demand. As shown in Table 4-3, that peaking factor is 2.6.
- **Step 7 Conservation Adjustment:** The methodology outlined in Steps 1 through 6 creates a baseline demand forecast. This baseline forecast was then adjusted for conservation. (Note that the conservation adjustment step is not shown on Figure 4-11.)

As a member of the Cascade Water Alliance (Cascade), which manages a conservation program for its member utilities, the City will continue conservation efforts beyond 2022 per those outlined in Cascade's conservation plan. Cascade will continue its current course of action through 2025. The conservation program will be updated when Cascade updates its Transmission and Supply Comprehensive Plan in 2025. The City will implement the new

conservation program and consider how it will impact future demands at that time. More information about the conservation program is in Chapter 5.

Novelty Hill Service Area

The Novelty Hill Service Area is considered built-out and thus the City does not anticipate any future growth. Therefore, the average demand from 2019 – 2021 for each customer category was calculated and summed to represent the base year demands. The same non-revenue factor was applied to Novelty Hill as the City Service Area. These demands were summed to determine the total demand in Novelty Hill, which was then held constant through the entire planning period.

Sammamish Plateau Water

For the water wheeled to Sammamish Plateau Water, the forecast for the average day demand used the quantity specified in the associated agreement between Redmond and the District, which is 160 acre-feet per year or 0.14 mgd. For the maximum day demand, a peaking factor was not applied to the District demand since that demand has historically occurred during the winter rather than the summer which is when the maximum day demand for Redmond's system as a whole typically occurs.

4.3.2. Demand Forecast Results

A summary of the projected demands for key years is provided in Table 4-11. The table includes demand forecasts both without and with additional conservation, as required by Washington State's Water Use Efficiency Rule. The demand without additional conservation shows the total average day demand increasing from 8.1 mgd in 2023 (base year of the water system planning period) to 9.4 mgd in 2033 (Year 10) and to 10.7 mgd in 2043 (year 20). The associated maximum day demand is expected to increase from 20.4 mgd in 2023 to 23.9 mgd in 2033 and to 27.2 mgd by 2043.

More detailed versions of these two demand forecasts are provided in Table 4-12 and Table 4-13.

Table 4-11. Demand forecast summary [a]

Year	Demand Without Additional Conservation				
	Average Day Demand (mgd)				Maximum Day Demand (mgd)
	City Service Area	Novelty Hill Service Area	Sammamish	Total	
2023 (Base)	7.22	0.74	0.14	8.10	20.55
2033 (10-Year)	8.52	0.74	0.14	9.41	23.89
2043 (20-Year)	9.82	0.74	0.14	10.71	27.23
Year	**Demand With Additional Conservation**				
	Average Day Demand (mgd)				Maximum Day Demand (mgd)
	City Service Area	Novelty Hill Service Area	Sammamish	Total	
2023 (Base)	7.17	0.74	0.14	8.05	20.50
2033 (10-Year)	8.46	0.74	0.14	9.33	23.82
2043 (20-Year)	9.76	0.74	0.14	10.64	27.16

[a] Total values differ slightly from the sum of the City Service Area, Novelty Hill Service Area, and Sammamish due to rounding.

The demand forecasts are shown in Figure 4-12. The various components of the average day demand without conservation are displayed in Figure 4-13, which provides information about the relative impact of each component.

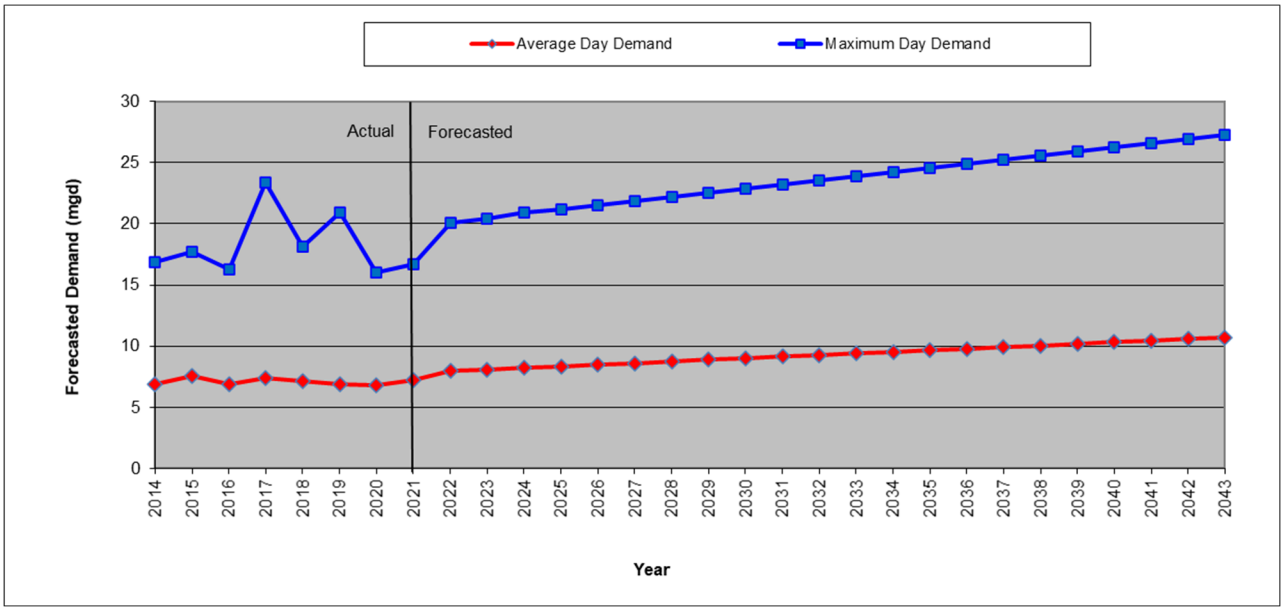

Figure 4-12. Demand forecast summary

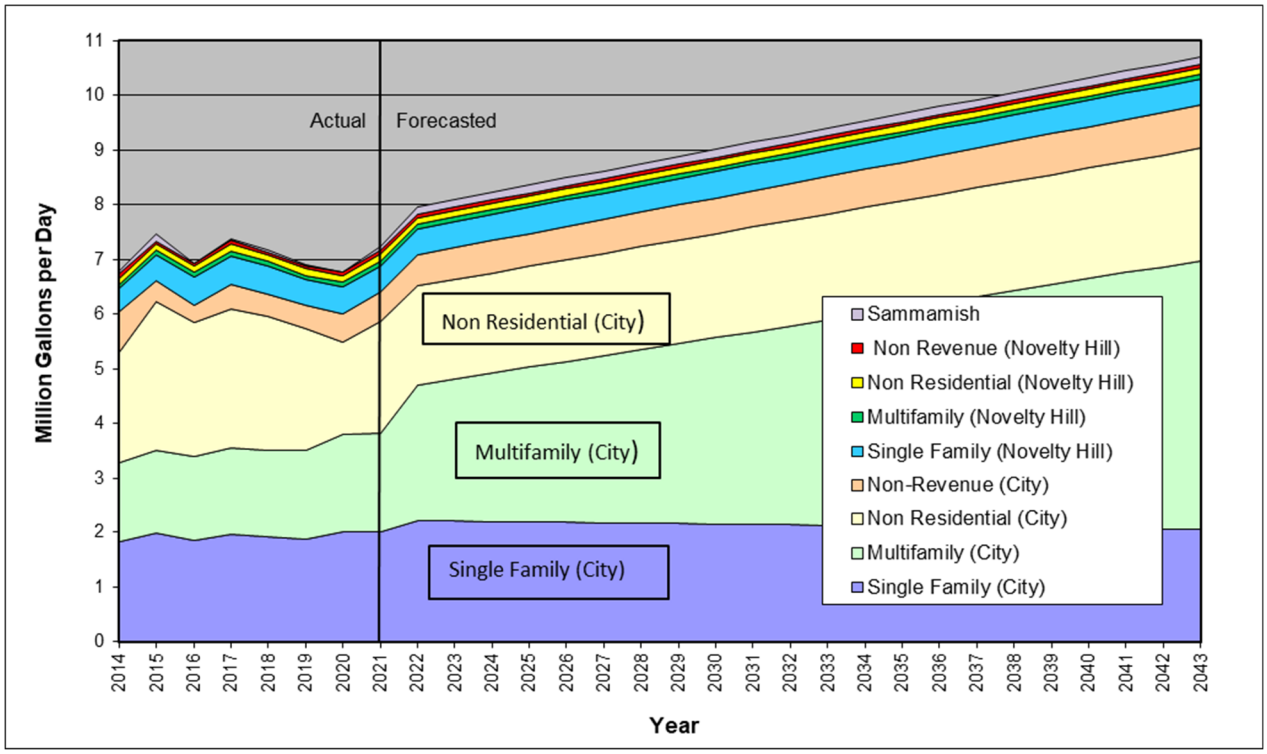

Figure 4-13. Demand forecast ADD details (without conservation)

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Table 4-12. Detailed demand forecast (without additional conservation)

Calendar Year	Plan Year	Demographics (for City Service Area)[a]			Water Use Factors (for City Service Area) (gpd)[b]			Demand														
								Average Day Demand (ADD mgd)														Maximum Day Demand (MDD mgd)[l]
								City Service Area						Novelty Hill Service Area						Sammamish Plateau WSD[j]	Total[k]	
		Single Family Households (SF HH)	Multifamily Households (MF HH)[i]	Employees	Per SF HH	Per MF HH	Per Employee	Single Family (SF)[c]	Multifamily (MF)[d]	Non Residential (NR)[e]	Subtotal[f]	Non-Revenue[g]	City Subtotal[h]	Single Family (SF)[i]	Multifamily (MF)[i]	Non Residential (NR)[i]	Subtotal[f]	Non-Revenue[g]	NH Subtotal[h]			
2022[m]	n/a	13,811	19,009	99,273	160	131	17	2.2	2.5	1.8	6.5	0.6	7.09	0.5	0.1	0.1	0.7	0.1	0.74	0.14	7.97	20.22
2023	0	13,762	19,892	99,972	160	131	17	2.2	2.6	1.8	6.6	0.6	7.22	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.10	20.55
2024	1	13,713	20,776	100,672	160	131	17	2.2	2.7	1.8	6.8	0.6	7.35	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.23	20.89
2025	2	13,664	21,659	101,371	160	131	17	2.2	2.8	1.8	6.9	0.6	7.48	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.36	21.22
2026	3	13,615	22,543	102,071	160	131	17	2.2	3.0	1.9	7.0	0.6	7.61	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.49	21.56
2027	4	13,565	23,426	102,770	160	131	17	2.2	3.1	1.9	7.1	0.6	7.74	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.62	21.89
2028	5	13,516	24,309	103,470	160	131	17	2.2	3.2	1.9	7.2	0.6	7.87	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.75	22.22
2029	6	13,467	25,193	104,169	160	131	17	2.2	3.3	1.9	7.4	0.6	8.00	0.5	0.1	0.1	0.7	0.1	0.74	0.14	8.88	22.56
2030	7	13,418	26,076	104,869	160	131	17	2.1	3.4	1.9	7.5	0.7	8.13	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.01	22.89
2031	8	13,369	26,960	105,569	160	131	17	2.1	3.5	1.9	7.6	0.7	8.26	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.15	23.23
2032	9	13,320	27,843	106,268	160	131	17	2.1	3.7	1.9	7.7	0.7	8.39	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.28	23.56
2033	10	13,271	28,726	106,968	160	131	17	2.1	3.8	1.9	7.8	0.7	8.52	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.41	23.89
2034	11	13,222	29,610	107,667	160	131	17	2.1	3.9	2.0	8.0	0.7	8.65	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.54	24.23
2035	12	13,173	30,493	108,367	160	131	17	2.1	4.0	2.0	8.1	0.7	8.78	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.67	24.56
2036	13	13,124	31,377	109,066	160	131	17	2.1	4.1	2.0	8.2	0.7	8.91	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.80	24.90
2037	14	13,074	32,260	109,766	160	131	17	2.1	4.2	2.0	8.3	0.7	9.04	0.5	0.1	0.1	0.7	0.1	0.74	0.14	9.93	25.23
2038	15	13,025	33,143	110,465	160	131	17	2.1	4.4	2.0	8.4	0.7	9.17	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.06	25.56
2039	16	12,976	34,027	111,165	160	131	17	2.1	4.5	2.0	8.6	0.7	9.30	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.19	25.90
2040	17	12,927	34,910	111,864	160	131	17	2.1	4.6	2.0	8.7	0.8	9.43	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.32	26.23
2041	18	12,878	35,793	112,564	160	131	17	2.1	4.7	2.0	8.8	0.8	9.56	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.45	26.57
2042	19	12,829	36,677	113,264	160	131	17	2.1	4.8	2.0	8.9	0.8	9.69	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.58	26.90
2043	20	12,780	37,560	113,963	160	131	17	2.0	4.9	2.1	9.0	0.8	9.82	0.5	0.1	0.1	0.7	0.1	0.74	0.14	10.71	27.23

[a] From Table 3-1 Demographics.

[b] From Table 3-9 Water Use Factors and ERUs.

[c] The number of single family households multiplied by the water use per single family household factor.

[d] The number of multifamily households multiplied by the water use per multifamily household factor.

[e] The number of employees multiplied by the water use per employee factor.

[f] The sum of the SF, MF, and NR demands.

[g] The sum of the SF, MF, and NR demands multiplied by the percent of non-revenue water as a percent of consumption, which is 8.7%. (Note this is intentionally different than non-revenue as a percent of production.)

[h] The sum of the SF, MF, and NR demands plus the non-revenue water.

[i] Demands are held constant at the 2019 - 2021 consumption average because Novelty Hill is built-out and demands are anticipated to remain nearly constant through the planning horizon.

[j] This is the quantity specified in the agreement between Redmond and Sammamish Plateau Water and Sewer District.

[k] The sum of the retail subtotals for the City and Novelty Hill, plus the Sammamish Plateau WSD water.

[l] The ADD subtotals from the City and Novelty Hill Service Areas multiplied by the City's 2019-2021 average peaking factor (which is 2.6) plus the ADD for Sammamish Plateau WSD. The peaking factor is not applied to Sammamish Plateau WSD since that demand has historically occurred during the winter rather than the summer which is when the MDD typically occurs.

[m] Year 2022 demands were determined using the same methodology as forecast years because data were unavailable during plan development.

Table 4-13. Detailed demand forecast (with additional conservation)

Calendar Year	Plan Year	Demographics (for City Service Area)[a]			Water Use Factors (for City Service Area) (gpd)[b]			Conservation Adjusted Demand Forecast (mgd)[c]				
		Single Family Households (SF HH)	Multifamily Households (MF HH)	Employees	Per SF HH	Per MF HH	Per Employee	City Service Area Subtotal (ADD)	Novelty Hill Service Area Subtotal (ADD)	Sammamish Plateau WSD (ADD)	Total (ADD)	Maximum Day Demand (MDD)
2022[d]	n/a	13,811	19,009	99,273	160	131	17	7.05	0.74	0.14	7.93	20.18
2023	0	13,762	19,892	99,972	160	131	17	7.17	0.74	0.14	8.05	20.50
2024	1	13,713	20,776	100,672	160	131	17	7.29	0.74	0.14	8.17	20.83
2025	2	13,664	21,659	101,371	160	131	17	7.41	0.74	0.14	8.29	21.15
2026	3	13,615	22,543	102,071	160	131	17	7.54	0.74	0.14	8.42	21.48
2027	4	13,565	23,426	102,770	160	131	17	7.67	0.74	0.14	8.55	21.82
2028	5	13,516	24,309	103,470	160	131	17	7.80	0.74	0.14	8.68	22.15
2029	6	13,467	25,193	104,169	160	131	17	7.93	0.74	0.14	8.81	22.49
2030	7	13,418	26,076	104,869	160	131	17	8.06	0.74	0.14	8.94	22.82
2031	8	13,369	26,960	105,569	160	131	17	8.19	0.74	0.14	9.07	23.15
2032	9	13,320	27,843	106,268	160	131	17	8.33	0.74	0.14	9.20	23.49
2033	10	13,271	28,726	106,968	160	131	17	8.46	0.74	0.14	9.33	23.82
2034	11	13,222	29,610	107,667	160	131	17	8.59	0.74	0.14	9.46	24.16
2035	12	13,173	30,493	108,367	160	131	17	8.72	0.74	0.14	9.59	24.49
2036	13	13,124	31,377	109,066	160	131	17	8.85	0.74	0.14	9.73	24.82
2037	14	13,074	32,260	109,766	160	131	17	8.98	0.74	0.14	9.86	25.16
2038	15	13,025	33,143	110,465	160	131	17	9.11	0.74	0.14	9.99	25.49
2039	16	12,976	34,027	111,165	160	131	17	9.24	0.74	0.14	10.12	25.83
2040	17	12,927	34,910	111,864	160	131	17	9.37	0.74	0.14	10.25	26.16
2041	18	12,878	35,793	112,564	160	131	17	9.50	0.74	0.14	10.38	26.49
2042	19	12,829	36,677	113,264	160	131	17	9.63	0.74	0.14	10.51	26.83
2043	20	12,780	37,560	113,963	160	131	17	9.76	0.74	0.14	10.64	27.16

[a] From Table 3-1 Demographics.
[b] From Table 3-9 Water Use Factors and ERUs.
[c] Conservation adjusted forecasted based on conservation assumptions described in Chapter 5. Conservation adjusted forecasts were only developed for service area subtotals; therefore, no customer class-specific conservation adjusted forecasts are displayed.
[d] Year 2022 demands were determined using the same methodology as forecast years because data were unavailable during plan development.

Chapter 5: Water Use Efficiency Program

City of Redmond Water System Plan DRAFT

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Figures

(Not applicable)

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5. Water Use Efficiency Program

This chapter has three purposes: 1) review the City's compliance with State water use efficiency (WUE) planning requirements, 2) describe the City's recent conservation program, and 3) describe the conservation program the City is implementing and anticipated timeline for a new program.

The conservation planning requirements that must be addressed in water system plans are contained in the following sources:

- State of Washington Water Use Efficiency Rule (January 2007)
- Department of Health Water Use Efficiency Guidebook (January 2017)
- Department of Health Water System Planning Handbook (August 2020)

The State of Washington revised water conservation planning requirements because of the 2003 Municipal Water Law. An outgrowth of that law is the Water Use Efficiency Rule (Rule), which was finalized in January 2007. The Rule has several requirements and corresponding compliance dates. Some of the requirements are associated with water system plans, while other requirements are independent of the water system planning cycle.

There are seven main categories of requirements: 1) meters, 2) data collection, 3) distribution system leakage, 4) goals, 5) efficiency program, 6) demand forecast, and 7) performance reports. The City has met all the requirements of the WUE rule in past planning cycles and continues to do so.

5.1. 2019-2022 WUE Program

The City participates in a regional conservation program administered by Cascade Water Alliance (Cascade). Conservation programs typically run on a six-year cycle where new goals and associated program must be reestablished. Cascade most recently updated and adopted its conservation program for 2019 through 2022. Cascade's plans to update its water use efficiency program and goals is discussed in Section 5.2.

5.1.1. Goals

Cascade's Board of Directors adopted the following WUE goal in November 2018:

> *"Cascade will dedicate the necessary resources to achieve cumulative drinking water savings of 0.4 million gallons per day on an annual basis by December 31, 2022."*

As a constituent member of Cascade, the City adopted this goal as their own in the 2020 Environmental Sustainability Action Plan (ESAP). The ESAP also calls for a water service area centric water consumption goal. The first step in developing this goal is to complete a comprehensive Water Use Reduction Strategy, which will specify the detailed water use reduction actions to expand on the broad strategies outlined in the ESAP. The Water Use Reduction Strategy will include evaluation of the appropriate water consumption reduction target for implementation.

5.1.2. Measures

Cascade provides its constituents with information about its WUE program through its annual report. The 2021 annual report is included as Appendix E.

Measures described in Cascade's annual report include:

Cascade provides its constituents with information about its WUE program through its annual report. The 2021 annual report is included as Appendix E.

Measures described in Cascade's annual report include:

- **Classroom presentations**, including a remote curriculum which can be used by teachers and parents where students can participate in a video chat session with an educator. The Blue Teams option offers a customized project over several classroom visits for a more in-depth study of a particular subject.

- **Problem-based learning for water system** program provides middle and high school teachers with a wide range of entry points including science, social studies, math, and language arts to incorporate the study of water into their classrooms.

- **Community learning** geared towards adult learners which included a watershed health series, home water use series, a field trip series, and the Cascade Gardner remote gardening classes promoting water efficiency.

- **Soil and water stewardship program** which provides free training to residents to learn about natural yard care, watershed health, drip irrigation, rain water harvesting, and other topics. These students can then bring their acquired knowledge back to their community. Cascade also supports the regional Garden Hotline.

- **Irrigation Assessments** which provide irrigation system assessments for high-peak season use customers.

- **Water watchers'** trainings and workshops for residents who are interested in monitoring local streams for watershed health

- **Participation in Fix-A-Leak Week** including distribution of toilet leak detection dye packets to multi-family and hotel properties.

- **Rebates for ENERGY STAR certified fixtures**

- **Free water efficient fixtures** available for order from the Cascade website.

- **Events,** such as fairs and festivals, including Redmond Derby Days, to promote water efficiency

Other actions related to water use efficiency that the City conducts include:

- **Source Meters:** The City has source meters on all of its wells and interties. The City does not have a formal calibration schedule. However, the City's work over the last decade to rebuild its wells has resulted in new meters on all wells. The rehabilitation

work has been completed at all five of the City's wells. Redmond's connections to the Seattle Public Utilities (SPU) transmission system, through which Redmond receives Cascade Water Alliance water, are also fully metered.

- **Service Meters:** Service meters at customer connections are another key component of providing accurate water information for conservation planning. The City has meters on all service connections. The City periodically tests its service meters and refurbishes or replaces malfunctioning meters. The City tests larger meters more frequently than smaller meters and strives to calibrate large commercial meters (3" and larger) approximately every year.

- **Leak detection and repair:** The City is proactive about leak control, even though it is not required to have a water loss control action plan since its leakage is low. The City relies on system break history, pipeline condition assessments, and projected future demands to identify and prioritize rehabilitation and replacement projects. As discussed in Section 4.2.3, the City's 2019 - 2021 average distribution system leakage was 8% of production and purchases. This result is within the 10% or less requirement of the WUE Rule and demonstrates that the City is successfully managing leaks.

- **Bills showing consumption history:** Customer bills providing historical consumption data allow customers to understand how their use varies throughout the year and from year to year. This information helps customers make informed choices about how they manage their water use, including implementing conservation. The City's customer bills include historical consumption data showing consumption for the previous 12 billing cycles, which typically covers two years.

4. Conservation Pricing

Rates can be used to encourage conservation action by customers. Rates typically consist of a fixed charge and a variable charge. There are four basic rate structures for the variable charge: uniform, declining block, increasing block, and seasonal. Both increasing blocks and seasonal rates are considered conservation pricing. Increasing blocks charge more per unit of consumption with additional consumption. Seasonal rates charge more per unit of consumption during the peak season.

Redmond's rate structure incorporates increasing blocks and seasonal rates, as well as irrigation rates that are higher than non-irrigation rates. The variable portions of Redmond's rates are shown in Table 5-1. The residential category uses an increasing block structure with four blocks. For both the City Service Area and the Novelty Hill Service Area, the fourth block is priced nearly four times higher than the first block. The commercial regular (i.e., non-irrigation) category uses seasonal rates. For the City Service Area, the summer rates are 71% higher than the winter rates. For the Novelty Hill Service Area, the summer rates are 44% higher than the winter rates. For commercial customers with dedicated irrigation meters, irrigation water is charged at a higher rate than non-irrigation water. For the City Service Area, the irrigation water rates are 48% higher than the summer rates for non-irrigation water. For the Novelty Hill Service Area, the irrigation water rates are 2.6 times higher than the summer rates for non-irrigation water.

Table 5-1. Variable Portion of Water Rates[1]

Residential – Charge per ccf							
City Service Area				Novelty Hill Service Area			
0 – 8.00 ccf	8.01 - 20 ccf	20.01 - 40 ccf	40.01+ ccf	0 - 8.00 ccf	8.01 - 18 ccf	18.01 - 32 ccf	32.01+ ccf
$1.95	$3.90	$5.85	$7.80	$4.01	$8.02	$12.03	$16.04
Commercial Regular – Charge per ccf							
City Service Area				**Novelty Hill Service Area**			
Winter Rate		Summer Rate		Winter Rate		Summer Rate	
$2.73		$4.67		$3.78		$5.46	
Commercial Irrigation – Charge Per ccf							
City Service Area				**Novelty Hill Service Area**			
$6.89				$14.41			

1. The dollar amounts are from Redmond's 2023 rates. 1 ccf = 748 gallons

5.1.3. Estimated Savings

The estimated conservation savings Cascade has achieved in the 2019 – 2022 WUE program are shown in Table 5-2. It is estimated that the conservation program saved approximately 227,892 gallons per day by the end of 2021, which is approximately 57% of the program savings goal. Redmond does not calculate conservation savings specific to its service area.

Table 5-2. Estimated Savings Achieved by Existing Program

Year	Savings (gpd – Annual Average)	
	Annual	Cumulative
2019	142,484	142,484
2020	48,316	190,800
2021	37,092	227,892

1. Retrieved from Cascade water efficiency annual reports

Moving forward, Cascade intends to continue or increase emphasis on teacher and student education on water issues and the relationship between water and climate change, and irrigation efficiency and sustainable landscape training.

5.2. Future WUE Program

Correspondence with Cascade's WUE director indicated the 2019 – 2022 goal associated program will be extended through at least 2024. Cascade will begin the process of updating its Transmission and Supply Plan in 2025, at which time the WUE program will be revisited and revised. Therefore, Cascade will continue to implement water use efficiency programs consistent with the 2019 – 2022 program with the intention to reach 500,000 gallons per day of savings across all seven Cascade members. This represents an additional 100,000 gallons per day of savings above the 2019 – 2022 goal.

5.2.1. Effect on Demand

The demand forecast presented in Section 3.3 includes two forecasts: one without additional conservation and one reflecting the additional savings from the conservation program. The Cascade 2021 Annual Water Efficiency Program Report stated that annual savings of 227,892 gallons per day had been achieved. To calculate savings through 2025, achievement of the 500,000 gpd goal in 2025 was assumed with linear growth towards that achievement (approximately 68,000 gpd additional savings per year from 2022-2025).

Cascade's savings goal is applied across all seven members and is not disaggregated into savings for each individual customer. To determine an approximate share of savings the City will achieve, the savings were divided by seven, the number of Cascade members. Table 5-3 displays the forecasted conservation savings by year for the Cascade service area and the City's portion. The annual average savings by year for the City were subtracted from the average day and maximum day demand forecasts. The total savings in 2025 were subtracted from all subsequent forecast years through the end of the forecast horizon.

Table 5-3. Estimated Savings Achieved by Existing Program

Year	Savings (gpd – Annual Average)	
	Total Savings	Redmond Portion
2022	295,919	42,274
2023	363,946	51,992
2024	431,973	61,710
2025	500,000	71,429

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Chapter 6: Distribution Facilities Design and Construction Standards

City of Redmond 2023 Water System Plan DRAFT

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6. Distribution Facilities Design and Construction Standards

This chapter provides an overview of the City's design and construction requirements for new facilities. These requirements have increased and become more stringent over time, with changes made as needed to reflect new construction materials and techniques, and to be consistent with state and national standards.

6.1. Project Review Procedures

For new water system facilities, the City has specific project review procedures. For projects that are cited in the water system plan, the main steps involved in water system project review are:

- Applicant completes the applicable permit applications and supporting documentation.
- Applicant describes the project and any existing planning information.
- Applicant may elect to have a pre-application meeting with City staff to learn more about the application requirements. Appropriate City staff includes staff from water, sewer, stormwater, streets, fire, parks, and planning.
- Applicant applies for and obtains a Utility Availability Certificate from Public Works.
- Applicant prepares preliminary engineering plans.
- Applicant submits the preliminary engineering plans to Development Services for its review.
- Planning (planner and engineers), Fire and Public Works review the application and plans and returns comments to the applicant. Applicant must respond to any comments from city reviewers to the reviewer's satisfaction.
- When the reviewers are satisfied that the application and plans meet all requirements, the project goes to the Technical Review Committee for approval.
- If approved, the Technical Review Committee issues a project approval letter. If not approved, the project goes back to the reviewers to ensure any issues are addressed prior to Technical Review Committee approval.
- Applicant develops final design and construction plans.
- Planning, Fire, and Public Works staff review the final design and construction plans. Applicant must respond to any comments from the Planning, Fire, and Public Works staff, to the Technical Review Committee's satisfaction.
- When the Planning, Fire, and Public Works staff are satisfied that the application and plans meet all requirements, they will approve the final design and construction plans.
- A preconstruction meeting is held.
- Construction commences.

For projects that propose to deviate from the current WSP, the City must first have the water system plan amended to include the proposed project. Then the steps outlined above must be followed for review of proposed projects. Additionally, if the project is outside the City Limits, then an application for service outside the City Service Area must be submitted for approval by the City Council.

Some water system projects must be forwarded to DOH for additional review and approval; specifically, those projects containing the following elements:

- Source of supply (including wells)
- Water quality treatment
- Reservoir/storage tank improvements
- Booster pump stations
- Tank coatings

Design and construction standards were most recently amended in October 2020 and are available on the City's website at: Standard Specifications (redmond.gov) They are incorporated in this WSP by reference. Therefore, the City is not required to submit plans for distribution mains for DOH review.

6.2. Policies and Requirements for System Additions

Policies and requirements for system additions, particularly for developer extensions, are provided in the *2019 City of Redmond Design Requirements: Water and Wastewater System Extensions* (Design Requirements (redmond.gov)). The design requirements in effect at the time of the 2011 plan were submitted to DOH in conjunction with the prior water system plan. Key policies guiding developer extensions are discussed in Section 2.5.4 of this water system plan.

Conceptual locations and sizes for new water mains are shown on the figures in Chapter 12 (Improvement Program). Not all required pipes are shown on these maps. Each development proposal will be reviewed by the City to determine actual required pipe and other facility sizes and locations.

6.3. Design Standards

The *Design Requirements* include some of the performance standards or levels of service discussed in the next section, and sizing criteria required in the design of all water system improvements. The City's sizing criteria meets or exceeds the minimum necessary to meet performance standards established in WAC 246-290. Additional design criteria are specified in the City's *2020 Standard Specifications and Details*, which is available on the City's website at Standard Specifications (redmond.gov).

6.4. Level of Service Criteria

The state has established minimum service criteria that all public water systems must meet. The City has developed water system level-of-service criteria, which are performance standards that help to ensure a safe, reliable source of supply for all customers. The City's level-of-service criteria meet or exceed all state requirements.

6.4.1. Distribution System Pressure Requirements

Minimum Service Pressure

WAC 246-290-230 establishes minimum system pressure requirements that must be maintained in all public water systems. These standards, particularly with respect to fire flow, have increased periodically since the first facilities in the City's system were constructed. The current pressure requirements defined by the state are:

- A minimum residual pressure of at least 30 psi must be maintained throughout the system during peak hour demand (PHD).
- A minimum residual pressure of at least 20 psi must be maintained throughout the distribution system during a fire flow event and assuming maximum day demand (MDD) conditions.

The City's design requirements for water and wastewater system extensions state that:

> *The system will be designed to have sufficient capacity to minimize pressure variations, provide minimum residual pressure of 40 psi at each meter during periods of maximum use, and provide sufficient volumes of water at adequate pressure to satisfy the expected maximum instantaneous demand plus fire flow.*

The City's requirements exceed state requirements, by requiring: 1) a minimum pressure of 40 psi, as opposed to 30 psi, during maximum use periods; and, 2) that minimum pressures be maintained during fire flow events and assuming maximum instantaneous demand conditions, as opposed to MDD.

Maximum Service Pressure

Although WAC 246-290-230 does not establish maximum allowable system pressure requirements, new facilities are typically designed to limit maximum system pressures to 100 psi. This criteria helps minimize the need for individual pressure-reducing valves (PRVs) at customer taps, which the local plumbing code requires on new service lines with pressures greater than 80 psi. The City's policy is not to retrofit areas with current service pressures exceeding 80 psi. However, individual customers can install their own PRVs if desired. In addition, if pressures in an area increase above 80 psi as a result of modifications made to the water system by the City, the City will assist affected property owners in the installation of individual PRVs.

Pressure Zones

The distribution system is divided into pressure zones to provide operational flexibility and to help meet minimum and maximum pressure requirements. Pressure zone boundaries generally follow ground contour elevations; however, physical boundaries such as streets and property lines are also used to simplify maintenance and operations. Pressure zones are separated by PRVs that automatically open, close, or throttle to maintain pre-set downstream service pressures.

From an operations and system reliability standpoint, it is desirable to keep the number of pressure zones to a minimum and to combine zones wherever possible. For reliable service to pressure zones, at least two PRVs will serve each zone, where possible. However, pressure

zones are established such that fire-fighting requirements can be met within a given zone assuming one PRV is out of service.

6.4.2. Fire Flow Requirements

Fire fighting requires a high rate of flow for a short period of time. Fire flow requirements typically are the most severe level of service criteria that must be met by a water system. These requirements are often the deciding factor when sizing distribution mains, defining pressure-zone boundaries, and sizing storage facilities.

The water system must have adequate supply, storage, and distribution capacity to supply fire-fighting requirements, while maintaining an adequate level of service to residential and commercial customers. WAC 246-290-230 defines adequate service as a minimum of 20 psi residual pressure anywhere in the system during the time the water system is supplying both the design fire flow and the projected maximum day demand. As noted earlier, the City requires that a 20-psi residual pressure be maintained under conditions that assume fire flow events during periods of maximum instantaneous demands. This standard exceeds state requirements.

The City of Redmond Fire Department is responsible for determining fire flow requirements for proposed multifamily, non-residential, or large single-family developments, using a formula based on criteria set forth by the Insurance Services Office (ISO). These criteria consider such variables as building floor area, type of construction, and exposure to other combustibles. Provision of automatic fire sprinklers is often a consideration in determining individual building fire flow requirements. In establishing design fire flows, the Redmond Fire Department also considers a reasonable response capability of the department itself, which is a function of such variables as available manpower and fire suppression equipment.

In general, a minimum design fire flow of 1,500 gpm is used for new single-family residential areas. For multi-family, non-residential, or large single-family developments, the design fire flows may be up to 3,500 gpm. If the fire flow requirement based on structure type and location is higher than 3,500 gpm, the structure design is typically modified to reduce the required fire flow to 3,500 gpm or less. The duration of design fire flows ranges from 2 to 4 hours for 1,500-gpm and 3,500-gpm fire flows, respectively. These service criteria are for new development and redevelopment projects. For existing structures, the distribution system should be able to provide the fire flow that was required when the structure was built.

6.4.3. System Storage Requirements

For new storage facilities, system storage volume requirements are comprised of the following five separate components.

- Operating storage
- Equalizing storage
- Fire flow storage
- Standby storage
- Dead storage

Figure 6-1 provides a graphical illustration of these storage components.

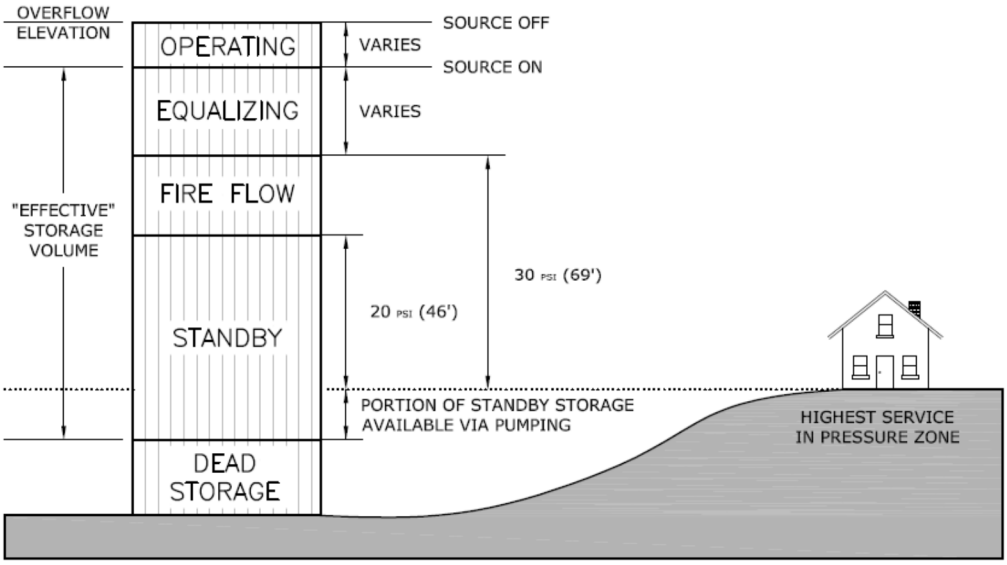

Figure 6-1. Storage Components

Operating and Dead Storage

Operating storage is defined in WAC 246-290-010 as "the volume of distribution storage associated with source or booster pump normal cycling times under normal operating conditions and is additive to the equalizing and standby storage components, and to fire flow storage if this storage component exists for any given tank." This is the volume of water that lies between low and high water-storage elevations set by City operations staff to control system pumps and flow-control valves.

Dead storage is defined in WAC 246-290-010 as "the volume of stored water not available to all consumers at the minimum design pressure." This is the volume at the bottom of the tank that cannot be used because it is physically too low to be withdrawn from the tank (i.e., located below the outlet pipe), provides poor water quality, or causes hydraulic problems at pump inlets such as pump cavitation or vortexing.

Operating and dead volumes are subtracted from the total storage volume of a tank to determine the available, or effective, storage in a tank.

Equalizing Storage

Equalizing storage is defined in WAC 246-290-010 as "the volume of storage needed to supplement supply to consumers when the peak hourly demand exceeds the total source pumping capacity." Equalizing volume requirements are greatest on the day of maximum demand. They are most often analyzed over a 24-hour demand cycle, although a longer cycle can be used. Operation of a properly balanced system results in replenishment of storage facilities during those times of day when the demand curve is below the capacity of the supply system, and withdrawal of water from storage when the demand exceeds the supply capacity.

The equalizing volume of a storage tank must be located at an elevation that provides a minimum pressure of 30 psi to all customers served by the tank.

Fire Flow Storage

Fire flow storage is defined in WAC 246-290-010 as "the volume of stored water available during fire suppression activities to satisfy minimum pressure requirements." This volume of a storage tank must be located at an elevation that provides a minimum pressure of 20 psi throughout the pressure zone served by the tank.

As previously noted, design fire flows within the City of Redmond were established by the Redmond Fire Department using criteria set by the ISO. These criteria relate building floor area, type of building construction, exposure to other structures, type of materials stored within the building, and other considerations to set a minimum required fire flow.

Within the City of Redmond, the maximum required fire flow is 3,500 gpm. The minimum fire flow duration is 4 hours. Required minimum fire flow volume is determined by applying a 3,500gpm fire flow over a 4hour time duration, resulting in a need for approximately 0.84 million gallons (MG).

Standby Storage

Standby storage is defined in WAC 246-290-010 as "the volume of stored water available for use during a loss of source capacity, power, or similar short-term emergency." This storage volume is required to supply a portion of system demands during a foreseeable system emergency or outage. Major system emergencies, such as those created by an earthquake, are intended to be covered by emergency system operations planning, since construction of sufficient standby storage volume to accommodate sustained system demands under emergency conditions is not economically feasible.

DOH has established guidelines for determining minimum required standby volume. As documented in Chapter 7 (Reservoir Design and Storage Volume) of DOH's *Water System Design Manual (June 2020)*, this component is calculated as the greater of: two times the average day demand (ADD), less multi-source credit; *or* 200 gallons times the number of ERUs served by the storage facility. The City has established standards that exceed this minimum criterion. A minimum standby volume of 400 gallons per ERU is required for all neighborhoods throughout the City except Novelty Hill. The standby component in the Novelty Hill area is set at 800 gallons per ERU because unlike other portions of the City, there are no redundant supply or storage facilities capable of serving that area.

The multi-source credit is applicable only for pressure zones that have multiple sources of supply, and allows the required standby storage volume in such instances to be reduced. The credit assumes the largest source of supply is out of service; thus, it is calculated as the total source available to a particular pressure zone, or zone combination, less the capacity of the largest source. No credit is allowed for zones having only one source of supply. The effect of the multi-source credit on the City's storage requirements in certain pressure zones may change in the future as the City transitions from receiving a portion of its water supply from the City of Seattle to receiving that supply from other Cascade Water Alliance sources. Design of future storage facilities will take this transition into consideration.

WAC 246-290-235(4) provides that "Standby and fire suppression storage volumes may be nested with the larger of the two volumes being the minimum available, provided the local fire protection authority does not require them to be additive." The Redmond Fire Department

approved nesting for the storage capacity analyses in the 2011 WSP and has stated the assumptions from that plan may be used again in this WSP update (Appendix F).

6.5. Construction Standards

The City's standard construction materials and methods are addressed by the City of Redmond's *2020 Standard Specifications and Details* (Standard Specifications (redmond.gov)) City of Redmond *Water and Wastewater Design Requirement* (Design Requirements (redmond.gov)) The City's standards are updated every two years by the Department of Public Works. Projects in County right-of-way in unincorporated King County must also meet the requirements of the *King County Road Standards.*

6.6. Construction Certification and Follow-Up Procedures

In order to assure that water projects are constructed according to the City's standards, the utility reviews all design drawings and specifications prior to construction. In addition, the City has construction staff present on each construction site to inspect construction of water facilities. Construction in King County right-of-way typically involves staff from the King County Utility Inspection Unit to ensure that work meets all applicable County construction standards.

The construction inspection staff includes several inspectors assigned to multiple projects throughout the City. During peak construction periods the City also utilizes inspectors hired through on-call agreements. Inspectors ensure that the system is built in accordance with the approved construction drawing along with the appropriate City, state, or federal standards.

All construction projects are required to have record drawings submitted to the Public Works Engineering Division for approval. In addition, per WAC 246-290-120(5), DOH requires that all water system projects complete a Construction Completion Report for Public Water System Projects.

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Chapter 7: Water Supply Resource Evaluation

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(Not applicable)

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7. Water Supply Resource Evaluation

This chapter includes an evaluation of the City's independent sources of supply and purchased water to determine the ability of its sources to meet existing and forecast demands within its water service area. The chapter also provides an evaluation of reclaimed water as a potential future supply source. Finally, this chapter contains discussion about the reliability of the sources of supply, contingency planning, and future supply improvements.

This is a planning document only, it is not intended as a definitive statement or analysis of the full scope of all water rights held by the City, or in which the City may have an interest. As noted later in this chapter, the Washington State Department of Ecology (Ecology) and the City have previously engaged in written communications regarding the extent and validity of the City's water right portfolio. Nothing herein shall be interpreted or used as a statement against the interests of, or binding upon, the City in any future proceeding or analysis concerning the scope of the water rights held by the City or in which the City may have an interest.

7.1. Existing Supply Sources

The City has two main sources of water supply: groundwater produced by its own wells, and regional surface water purchased through membership in Cascade Water Alliance. Approximately 40 percent of the City's existing demands are served by the City's wells, and the remaining 60 percent is supplied by Cascade (see Figure 3-1).

The City's five wells exclusively supply the Well Service Area, which is supplemented by purchased water from Cascade during periods of peak demand. The Overlake/Viewpoint and Rose Hill Service Areas receive water purchased from Cascade, which originates at Seattle's Tolt Reservoir and is delivered through the Tolt Eastside Supply Line (TESSL).

The Novelty Hill Service Area is served completely by wholesale water purchased from Cascade. The City's purveyor tap is off the Tolt Tie Line, which connects SPU's Tolt Pipeline No. 1 and Tolt Pipeline No. 2. Water from the Tie Line is conveyed to the Novelty Hill booster pump station, where it is then pumped into the Novelty Hill storage tanks.

Under the Cascade Interlocal Contract, Redmond retains ownership and control of its own groundwater sources, and Cascade commits to meeting Redmond's water supply needs exceeding the capacity of the City's local sources.

7.1.1. Redmond's Groundwater Supply

The City owns and operates five wells within the Well Service Area. All five wells were reconstructed in the past as part of the City's source improvement project.

As a member of Cascade having its own independent supply, Redmond has committed to producing water from its groundwater sources. An "Independent Supply Production Requirement" is defined based on a Member Water Audit prepared for Cascade and updated in July 2022. Redmond's Production Requirement, which was established during the May 2008 Cascade Member Water Audit is shown in Table 7-1. The production requirements have increased as Redmond redeemed available Regional Capital Facilities Charge (RCFC) credits from Cascade over a period of time.

Table 7-1. Cascade Independent Supply Production Requirements

Production Metric	Initial Production Requirement (2008)	Final Production Requirement
Average Day	2.20 mgd	2.60 mgd
Peak Season	2.58 mgd	3.51 mgd
Peak Day	3.90 mgd	3.90 mgd

7.1.2. Cascade Supply

As a Member of Cascade the City has access to contracted water supply. At this time, Cascade's contracted water enters the Redmond system from the regional supply system owned and operated by Seattle Public Utilities (SPU). Redmond has seven connections to the regional supply system. Two connections to SPU's Tolt Pipeline No. 2 (TPL#2) serve the Well Service Area. Three connections to SPU's Tolt Eastside Supply Line (TESSL) serve the Rose Hill service area. These three connections are shared with the cities of Bellevue and Kirkland. An additional connection to the TESSL (at NE 40th St.) serves the Overlake/Viewpoint service area, and is shared with the City of Bellevue. The City's final supply connection is to SPU's Tolt Tie Line and serves Novelty Hill.

Cascade's contract with SPU was described in Section 2.3.4 of this Water System Plan. Cascade also has contracted supply from Tacoma Public Utilities. Cascade's supply strategy is more fully described in Cascade's 2012 Transmission and Supply Plan, which had a limited update in 2019. Based on Redmond's proximity to the Tolt system on the north and the sufficiency of the SPU supply, it appears likely that water originating at SPU's Tolt source will continue to be used in Redmond for many decades to come. Redmond has no current plans to utilize the contracted supply from Tacoma Public Utilities. However, as Cascade's mix of supply resources changes over time, Redmond's sources may also change.

Cascade will be updating its Transmission and Supply Plan in 2025. The City will actively participate in the process and consider how Cascade's source profile will impact the City's supply reliability.

7.2. Water Rights

The City's water rights consist of six groundwater rights associated with five wells and two surface water rights associated with Seidel Creek. In 2004, Ecology reviewed the City's water rights at the City's request, resulting in an exchange of letters with Ecology. Copies of the water rights and the above referenced letters are on file at the City's Public Works Department.

7.2.1. Groundwater Rights

Well No. 1

Well No. 1 has two water right certificates associated with it. Certificate 1313-A has a priority date of July 23, 1951 and Certificate G1-00130C has a priority date of February 3, 1972 (see Table 7-2). Certificate 1313-A has a permitted instantaneous pumping rate of 200 gpm and an annual quantity of 224 acre-feet. Certificate G1-00130C has a permitted instantaneous pumping rate of 700 gpm and an annual quantity of 1,120 acre-feet. The total combined right is 900 gpm with an annual quantity of 1,344 acre-feet (afy).

Well No. 2

Well No. 2 is associated with Certificate 3420-A, with a priority date of July 25, 1958, a permitted instantaneous pumping rate of 500 gpm, and an annual withdrawal quantity of 605 acre-feet. One of the conditions on the Report of Examination for this water right was that the combined, primary water rights associated with Certificate 1313-A (see Well No. 1) and 3420-A was set equal to 605 acre-feet. Therefore, the maximum annual quantity that can be withdrawn under Certificate 3420-A is 605 acre-feet less the annual quantity withdrawn under Certificate 1313-A (Well No. 1). If the entire amount of Certificate 1313-A is not withdrawn from Well No. 1, then that amount not withdrawn from Well No. 1 may be withdrawn from Well No. 2 (up to a maximum amount of 605 acre-feet if well No. 1 withdraws 1,120 acre-feet or less).

Well No. 3

Well No. 3 is associated with Certificate 6675-A, with a priority date of November 27, 1968, a permitted instantaneous pumping rate of 480 gpm, and an annual quantity of 400 acre-feet.

Well No. 4

Well No. 4 is associated with Certificate G1-22608C, with a priority date of November 5, 1975. This certificate is a primary water right and has a permitted instantaneous pumping rate of 800 gpm and an annual quantity of 1,280 acre-feet.

Well No. 5

Water Right Certificate G1-24204C has a priority date of November 17, 1982. This certificate is a primary water right and has a permitted instantaneous pumping rate of 1,000 gpm, and an annual quantity of 1,600 acre-feet, granted for Well No. 5.

7.2.2. Surface Water Rights

The City has two surface water rights for diversions from Seidel Creek. The first surface water right, Certificate 249, is for a permitted diversion of five cubic feet per second (cfs) (2,244 gpm) and has a priority date of April 5, 1927. The second right, Certificate 250, is for 33 acre-feet per year (afy) of impoundment storage and also has a priority date of April 22, 1927. The Seidel Creek water rights have historically been beneficially used for fish, wildlife, and other instream flow resources or related habitat values pursuant to RCW 90.03.550.

7.2.3. Comparison with Current and Future Needs

Based on the City's groundwater right certificates, the City's total instantaneous rights equal 3,680 gpm and its total primary annual rights equal 5,005 afy. The City supplements its water rights with water purchased from Cascade Water Alliance.

The City may need to seek approval for changes in locations of points of withdrawal for their existing groundwater rights to continue to have the capability to pump groundwater up to their maximum authorized instantaneous and annual quantities.

Table 7-2 provides a summary of the City's water rights and water provided via interties with Cascade, and a comparison to the City's existing consumption and forecasted water demand.

The City does not anticipate needing to apply for additional water rights during the 20 year planning period of this Water System Plan.

Table 7-2. Water Rights Self-Assessment

Certificate/Permit Number	Priority Date	WFI Source #	Existing Water Rights			Base Year Production (2023)				10-Year Forecasted Production				20-Year Forecasted Production			
			Primary Qi (gpm)	Primary Qa (afy)	Non-Additive Qa (afy)	Total Qi (gpm)	Excess or Deficiency (gpm)	Total Qa (afy)	Excess or Deficiency (afy)	Total Qi (gpm)	Excess or Deficiency (gpm)	Total Qa (afy)	Excess or Deficiency (afy)	Total Qi (gpm)	Excess or Deficiency (gpm)	Total Qa (afy)	Excess or Deficiency (afy)
Surface Water																	
249 (Seidel Cr.)	4/5/1927		2,244	n/a	n/a	*n/a* [1]											
250 (Seidel Cr.)	4/22/1927		n/a	n/a	n/a												
Groundwater																	
1313-A (Well 1)	7/23/1951	S15	200	224		*See totals below* [2]											
3420-A (Well 2)	7/25/1958	S16	500	381	224												
6675-A (Well 3)	11/27/1968	S03	480	400													
G1-00130C (Well 1)	2/3/1972	S15	700	1,120													
G1-22608C (Well 4)	11/5/1975	S04	800	1,280													
G1-24204 (Well 5)	11/17/1982	S07	1,000	1,600													
TOTALS (Groundwater Only):			3,680	5,005	224												
Interties [3]																	
Cascade Water Alliance			*n/a* [4]			*See totals below* [2]											
42250T/Kirkland	n/a	S05															
05575B/Bellevue		S06															
77050Y/Seattle		S08															
TOTALS (Cascade) [5]:			28,648	46,249	n/a												
TOTALS (Combined):			32,328	51,254		14,273	18,055	9,083	42,172	16,593	15,735	10,543	40,711	18,913	13,415	12,003	39,251

[1] Seidel Creek water rights are beneficially used for instream flow purposes and the amounts (Qi and Qa) attributable to these water rights are not included in the total water rights currently available to the City's water system.
[2] Production values for each source were not forecasted. Future production is considered as a whole.
[3] Only non-emergency interties with Cascade Water Alliance are considered in this analysis.
[4] Water acquired through interties from Cascade Water Alliance is based on instantaneous needs.
[5] Total instantaneous rate based on hydraulic capacities of interties described in Table 3-7. Total annual volume based on the instantaneous rate applied over the course of a year.

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7.3. System Reliability

This section describes features of the water system that contribute to the reliability of water supply.

7.3.1. Reliability Considerations

Well Service Area

The Well Service Area has four potential sources of supply that can provide its water. First, the City's wells provide the main source for that area. Second, the City has two supply connections with Seattle's Tolt Pipeline No. 2: one at NE 104th Street and 160th Avenue NE, and the other on NE 172nd Street. Wholesale water supplied through these connections supplements the City's own source of supply during peak demands in the Well Service Area. Approximately 14 million gallons per day (mgd) can be supplied through these connections. The third source of supply is comprised of three flow-controlled connections with the Rose Hill Service Area that can provide approximately 3 mgd. These connections between service areas are normally closed and do not provide water on a regular basis. Finally, an emergency intertie with Northeast Sammamish Sewer and Water District can provide additional supply if needed.

Well #4 has historically experienced issues with production capacity. Physical issues such as screen clogging and water quality issues with manganese and iron limit its functionality and prevent the City from exercising the well's full water right. Since the early 2000s, the City has considered options to remedy this issue including changing the point of withdrawal for the water right, redrilling the well and filing a showing of compliance with Ecology. The City continues to evaluate the best resolution for Well 4.

The City's two connections with Tolt Pipeline No. 2 provide sufficient supply capacity to fully meet needs in the Well Service Area in the event the wells are not available. The connections to the Rose Hill Service Area offer additional supply reliability, though they alone are not capable of fully supplying average day demand.

Rose Hill and Overlake/Viewpoint Service Areas

The Rose Hill and Overlake/Viewpoint Service Areas have interconnections through which demands to the two service areas can be met in a variety of ways. The Rose Hill Service Area is normally served through three connections to the TESSL. It also has connections to the Overlake/Viewpoint area for use in the event the three TESSL connections are not available. While normally served by one connection to the TESSL, the Overlake/Viewpoint Service Area can receive water from Rose Hill in the event its TESSL connection is not available. The Overlake/Viewpoint area can also receive water through the City of Bellevue system's other TESSL connections.

Novelty Hill Service Area

Novelty Hill's supply is provided through a connection to the Tolt Tie Line, which connects Tolt Pipeline Nos. 1 and 2. Storage capacity within that service area provides short-term provisions for meeting demands if anything should occur to the intertie that normally serves that area. Emergency interties with adjacent purveyors (Woodinville and Union Hill) provide a backup source of supply for short-term purposes.

Interties

The City's existing interties are discussed in Chapter 3.7. In addition to its supply connections, the City has interties for emergency supply purposes, in the event its primary supplies are unavailable. Existing interties are listed in Table 3-8. Redmond is currently planning to develop an additional intertie with Woodinville at 172nd Avenue NE. This intertie would provide additional capacity, particularly to meet peak day demands within the Well Service Area, and provide additional redundancy in the system.

Water Shortage Response Planning

The City's Water Shortage Response Plan (2009) outlines procedures to be followed in the event supply from Cascade or from the City's wells are reduced or disrupted due to a drought or emergency. The Water Shortage Response Plan is on file at the City's Public Works Department.

7.4. Evaluation of Reclaimed Water Opportunities

DOH requires that water system plans include an evaluation of opportunities to use reclaimed water. Reclaimed water is wastewater that has been highly treated to permit it to be used again for purposes specified under State law. Use of reclaimed water can help water systems stretch their available supplies and reduce withdrawals of water from aquifers or surface streams. However, retrofitting a reclaimed water supply to an existing community poses significant costs and other challenges.

For more than two decades, the City has worked with Cascade Water Alliance and King County to explore the feasibility of reclaimed water use within the City. Specific potential opportunities for use of this resource have been identified in previous planning documents including Cascade's 2005 and 2012 Transmission and Supply Plans, as well as the City's prior water system plans.

The location of King County's Brightwater Treatment Plant to the north of the City in Snohomish County, and that facility's associated Sammamish Valley "South Backbone" reclaimed water transmission line that extends into the northern portion of the City's retail service area, has prompted more detailed consideration of reclaimed water use over the past 10 years. King County provides reclaimed water directly to customers located within or near the City. These include irrigation uses at the Willows Run Golf Course and the 60 Acres Soccer Complex, and a reclaimed water fill station at the County's York Pump Station. Additional uses that could be potentially served by the South Backbone reclaimed water transmission line were studied in 2018 by Cascade and King County, with participation by the Cities of Redmond, Kirkland, and Bellevue. Ultimately, it was concluded that the high cost of pumping and piping this water to various use locations was prohibitive to implementation in the near future.

In addition, other considerations regarding reclaimed water use have been evaluated, including the potential for impacts of certain uses to Redmond's groundwater quality. As discussed in detail in Section 2.3.8, the City has limited the use of reclaimed water within its critical aquifer recharge area (CARA) to those uses that discharge to the sanitary sewer. Memoranda of Understanding (MOUs) between the City and King County reflect these limitations, even in portions of the CARA that extend beyond the City's retail service area, so as to be protective of aquifer water quality. Additionally, King County and Cascade Water Alliance have entered into

an MOU that applies to all service areas of Cascade members regarding reclaimed water planning and coordination.

For the reasons noted above pertaining to CARA-based limitations and high costs of additional infrastructure needed for delivery, and because the City is already investing substantial funds to secure long-term potable water supplies as a member of the Cascade Water Alliance, use of reclaimed water for additional applications within the City's service area appears to offer little direct benefit to the City's water customers at this time. Therefore, the City of Redmond does not plan to invest water utility funds in construction of a reclaimed water delivery system in the near future. However, the City remains open to proposals from King County or other parties related to reclaimed water, if alternative funding sources can be identified to finance the necessary construction projects and if the proposals meet reclaimed water use requirements as established by City code and the aforementioned MOUs.

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Chapter 8: Water Quality

City of Redmond 2023 Water System Plan DRAFT

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8. Water Quality Regulations and Compliance

The City of Redmond manages its water system to achieve compliance with state and federal rules and regulations. These include the federal Safe Drinking Water Act (SDWA) and state regulations outlined in Washington Administrative Code (WAC) 246-290. This chapter reviews the City's compliance with these requirements.

Redmond treats water from its independent supply sources to comply with requirements for water sources. City personnel generate sodium hypochlorite on-site for disinfection of the well water. Sodium fluoride also is added at the well sites for its dental benefit. CO2 stripping is provided at the City's wells to increase pH for corrosion control, except at Well No. 4 where sodium hydroxide is used.

Water received from the regional supply system is treated at the source by Seattle Public Utilities. Where regional supply water passes through Bellevue or Kirkland, some localized treatment also may occur prior to entry into Redmond's distribution system. Redmond works closely with these partner utilities to maintain a high level of water quality delivered to the City's customers.

The City's Maintenance and Operations Center (MOC) monitors water quality conditions within the City's distribution system. Water samples are collected at various locations throughout the City's service area to verify compliance with state and federal regulations. Table 11-4 in Chapter 11 presents the chemical, physical, and bacteriological parameters that are part of the MOC's regular monitoring program. Also included in Table 11-4 is the frequency that each parameter is tested. The City's status is discussed in terms of effective source water, distribution system, and other applicable and anticipated regulations.

8.1. Safe Drinking Water Act

The federal regulatory framework directing water quality is the Safe Drinking Water Act (SDWA) of 1974 and its 1986 and 1996 amendments. The SDWA and amendments, as administered by the United States Environmental Protection Agency (EPA), have impacts on the operation and monitoring of the Redmond water system. The regulatory impacts to Redmond include requirements for disinfection, limits on bacteriological quality and disinfection by-products, and monitoring for various types of potential contaminants in source waters and within the City's distribution system.

8.2. Washington Administrative Code

Chapter 246-290 WAC incorporates the SDWA and its amendments. The Washington State Department of Health (DOH) has primacy for ensuring these requirements are implemented and enforced. The Redmond system (ID #71650B) is classified as Group A public water system and is therefore required to meet drinking water quality regulations and conform to sampling and reporting requirements for Group A systems.

Drinking water quality regulations currently applicable to the City are listed in Table 8-1. These regulations are classified as pertaining to the source water, distribution system, or other effective rules. Anticipated regulations are discussed separately at the end of this chapter.

Table 8-1. Safe Drinking Water Act Rules Applicable to Redmond System

Rule	Parameters Regulated	WAC or FR*
Source Water Quality Regulations		
National Primary and Secondary Drinking Water Standards (1976)	Physical and Chemical	40 FR 141
Phase 1 (VOCs), Phase 2 and Phase 5 Rules (IOCs and SOCs) (1994)	Volatile organic compounds (VOCs), inorganic chemicals (IOCs), and synthetic organic chemicals (SOCs)	246-290-300(4) and (7)
Surface Water Treatment Rule (1990) and Long-Term 2 Enhanced Rule (2006)	Turbidity, disinfection, viruses, Giardia lamblia, chlorine residual, and cryptosporidium.	246-290-451
Arsenic Rule (2006)	Arsenic	246-290-300(4)
Radionuclides Rule (1976, 2003)	Combined radium, gross alpha, beta and photon emitters, and uranium	246-290-300(8)
Groundwater Rule (2010)	Viruses, fecal indicators	246-290-300(1) 71 FR 224 (Nov 21, 2006)
Wellhead Protection Program	Planning tool to identify potential sources of contamination and protect drinking water supplies	246-290-135(3)
Unregulated Contaminants Monitoring Rule 4 (2018)	Various contaminants considered for future regulations	N/A
PFAS Rule (TBD)	TBD	TBD
Distribution System Water Quality Regulations		
Final Lead and Copper Rule and Revisions (2021)	Lead, copper, water quality parameters, treatment for corrosion control, and replacement of lead service lines.	246-290-300(5)
Total Coliform Rule (2018)	Total and fecal coliform, E. coli	246-290-300(2) and (3)
Stage 1 Disinfectants/Disinfection By-Products Rule (2002)	Trihalomethanes, haloacetic acids, chlorine residual, total organic carbon, others	246-290-300(6)
Stage 2 Disinfectants/Disinfection By-Products Rule (2006)	Trihalomethanes, haloacetic acids	71 FR 388 (Jan 4, 2006)
Other Regulations		
Consumer Confidence Reports and Public Notification Rules (1998/2000)	Requires annual report addressing drinking water quality and notifications of water quality violations.	246-290-71001 through 246-290-72012
Operator Certification	Requires minimum standards for operator certification by State	246-292

* WAC – Washington Administrative Code; FR – Federal Register

8.3. Source Water Regulations

This section summarizes water quality regulations that pertain to sources and are applicable to the City. In prior WSPs, Maximum Contaminant Limits (MCLs) and observed sample ranges were listed for all regulated contaminants. For this WSP update, the sections have been streamlined and no longer show tables of all contaminants, their MCLs, and the observed sample range. This information is available on the DOH Sentry webpage. This section now describes each water quality regulation applicable to the City, how the City is meeting those standards, and if any exceedances were observed during the prior planning period.

A discussion of each rule and Redmond's status follows.

8.3.1. National Primary and Secondary Drinking Water Standards

National Primary Drinking Water Standards are currently set for 87 contaminants. MCLs and maximum contaminant level goals (MCLGs) have been established for 77 contaminants, while the remaining ten have treatment technique requirements. A constituent's MCL is generally based on its public health goal (PHG), which is the level of a contaminant in drinking water below which there is no known or expected health risk. Regulated constituents include microbial contaminants, inorganic chemicals (IOCs), volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs), radionuclides, and disinfection by-products (DBPs). Regulations affecting DBPs are discussed in the distribution system water quality section.

The EPA regulates most of the chemical contaminants through the rules known as Phase I, II, IIb, and V. The EPA issued the four rules regulating 69 contaminants over a five-year period as it gathered, updated, and analyzed information on each contaminant's presence in drinking water supplies and its health effects. The Phase I Rule was promulgated July 8, 1987 and included eight VOCs. The Phase II and IIb Rules (published January 30 and July 1, 1991) updated or created new limits for 38 contaminants. The Phase V Rule (published July 17, 1992), set standards for 23 additional contaminants. These rules form the basis of the Washington Department of Health regulations described in WAC 246-290-300. Since the Phase V Rule, MCLs for additional contaminants have been established through new regulations, such as the Arsenic Rule, and were adopted by DOH.

WAC 246-290-300 requires that these compounds be monitored at each source on 12-to-36-month sampling cycles depending on the contaminant and source type. As part of the Phase II Rule, systems with a significant amount of asbestos-cement (AC) pipe must conduct periodic asbestos monitoring in the distribution system. The City's status regarding the Asbestos Rule is discussed later in the section pertaining to distribution water quality.

The EPA has also established secondary standards for 15 contaminants to address the aesthetic quality of drinking water; these secondary standards have also been adopted within the WAC. Because the federal standards primarily address taste and odor, rather than health issues, they are often used only as a guideline. For existing public water systems, the WAC stipulates that the required follow-up action be determined by the DOH based on the degree of consumer acceptance of the water quality and their willingness to bear the cost of meeting the secondary standard.

Redmond has maintained compliance with the primary drinking water regulations in the City's service areas. SPU is responsible for conducting monitoring per regulations for drinking water supply sources under their control, which would include responsibility for ensuring compliance with the Phase I, II, and V regulations for the imported supplies.

The following subsections describe the contaminants regulated under national standards in more detail.

Volatile Organic Compounds

Volatile organic chemicals (VOCs) are manufactured, carbon-based chemicals that vaporize quickly at normal temperatures and pressures. VOCs include many hydrocarbons associated with fuels, paint thinners, and solvents. VOCs are divided into the two following groups:

- Regulated VOCs that have been determined to pose a significant risk to human health.
- Unregulated VOCs for which the level of risk to human health has not been established.

There are currently 21 regulated volatile organic chemicals (VOCs).

Redmond's monitoring requirements differ by source and are described in the Water Quality Monitoring Schedule (WQMS) (Appendix F). No VOC exceedances have been observed during the prior planning period.

Synthetic Organic Compounds

DOH regulates 33 Synthetic Organic Compounds. This group includes organic pesticides and other synthetic chemicals. The City received waivers for monitoring of dioxin, diquat, endothall, ethylene dibromide, and glyphosate. Monitoring requirements by source are described in the WQMS. No SOC exceedances have been observed during the prior planning period.

Inorganic Compounds

Regulated inorganic chemicals include elemental metals such as mercury, arsenic, and iron. Some non-metallic constituents such as chloride, fluoride, and sulfate are also included in this category. Physical properties of IOCs that affect water quality in this category include turbidity, specific conductivity, total dissolved solids, and color. WAC 246-290 specifies primary and secondary MCLs for IOCs. Asbestos samples are collected from the distribution system since the source of asbestos is asbestos cement pipe. As such, this requirement is discussed in a future section.

DOH granted a waiver for IOC monitoring, and Redmond is required to monitor for IOCs once every 9 years. The most recent sample was taken on May 3, 2017. No exceedance was observed.

8.3.2. Arsenic Rule

EPA published the final Arsenic Rule in January 2001 with an effective date of January 2006. The Arsenic Rule established the arsenic MCL at 0.010 mg/L and it identifies several best available treatment technologies for compliance. The rule makes arsenic monitoring requirements consistent with monitoring for other inorganic chemicals regulated under the Phase II/V standardized monitoring framework. Compliance with the MCL is based on the running annual average of monitoring results at each entry point to the distribution system. However, if arsenic is detected above the MCL in any individual sample, the system must increase the frequency of monitoring at that sampling point to quarterly.

The City had no arsenic exceedances during the prior planning period.

8.3.3. Radionuclides Rule

The Radionuclides Rule was updated in December 2000, with an effective date of 2003. The rule includes MCLs for radium-226 and radium-228, referred to as combined radium (5 pCi/L), adjusted gross alpha emitters (15 pCi/L), beta and photon emitters (4 mrem/year), and uranium (30 µg/L). Under this rule, monitoring for radionuclides must be conducted after the point of treatment for each well and before the first customer receives the water. Systems are required to conduct initial monitoring between 2003 and 2007, unless earlier radionuclide data can be used as grandfathered data. The required monitoring frequency will depend on system contaminant levels observed during initial monitoring.

Redmond tested all wells with the exception of Well #4 for gross alpha in 1997. Well #4 was out of service until 2002, so gross alpha was tested for Well #4 in 2003 per DOH request. Redmond now samples for radionuclides at all sources on a six year schedule. The most recent sample date was June 19, 2019. No exceedances were observed.

8.3.4. Groundwater Rule

The Groundwater Rule (GWR), promulgated November 8, 2006, applies to all public water systems that use groundwater for all or part of their drinking water supply, unless the groundwater sources are under the influence of surface water or groundwater and surface water are blended prior to treatment. The basic requirements of the Groundwater Rule include triggered source water monitoring or compliance monitoring, sanitary surveys, corrective actions, and public notification. DOH adopted the federal Groundwater Rule on September 30, 2010 and it went into effect on November 1, 2010.

The City has chosen the source water "triggered monitoring" option for compliance with the Groundwater Rule. This means that triggered source water monitoring for *E. coli* is required within 24 hours of notification that a routine distribution system or consecutive system coliform sample is positive under routine TCR monitoring. The City is then required to test each source (prior to treatment) that was in operation at the time the positive routine TCR sample was collected.

8.3.5. Wellhead Protection Program

Per WAC 246-290-135(3), public water systems are required to implement a Wellhead Protection Program (WHPP) to protect their groundwater supplies. Source water protection programs are planning tools to be used by water utilities to identify potential sources of water contamination, and to protect existing and future drinking water supplies.

A WHPP has been prepared for the Redmond system and is discussed in Chapter 9 of this Water System Plan.

8.3.6. Unregulated Contaminant Monitoring Rule

The 1986 amendments to the Safe Drinking Water Act require public water systems to monitor for unregulated contaminants every five years and submit these data to the states. The intent of this program is to gather scientific information on unregulated contaminants and find unregulated contaminants of concern in the nation's drinking water to determine if regulations are required to protect human health. Both the 1993 and 1996 amendments to the Act added new lists of contaminants, which led EPA to develop a revised program for monitoring. The new

program became known as the Unregulated Contaminant Monitoring Regulations (UCMR 1999). The new UCMR program began in 2001 and produces a new list of unregulated contaminants for monitoring every five years.

Unregulated Contaminant Monitoring Regulation 1 (UCMR 1) required all public water systems (PWSs) serving more than 10,000 people to monitor for unregulated contaminants from 2001-2005. Unregulated Contaminant Monitoring Regulation 2 (UCMR 2) required further sampling for additional parameters during 2008-2010. This monitoring cycle included 25 unregulated contaminants (10 “List 1” and 15 “List 2”) and five associated analytical methods. Redmond completed UCMR 1 with samples collected from groundwater sources in June and November 2002. UCMR 2 samples were collected in October 2009 and April 2010.

UCMR 3

The UCMR supporting the second cycle (UCMR 3) of monitoring was published on May 2, 2012. The UCMR 3 requires monitoring for two lists of 30 contaminants during 2013 and 2015.

All PWSs serving more than 10,000 people, and 800 representative PWSs serving less than 10,001 people were required to monitor for the 10 “List 1” contaminants during a 12-month period between January 2013 and December 2015. Systems serving more than 100,000 people (including both retail and wholesale customers) and selected smaller systems were required to conduct screening monitoring for 15 “List 2” contaminants on the Screening Survey List. This list includes contaminants that will be monitored at distribution system entry points and within the distribution system.

The City collected samples for UCMR 3 throughout 2014 and 2015 for the 10 “List 1” contaminants based on the population in the service area. There were detections of Strontium, Vanadium, Hexavalent Chromium, and Chlorate in this round of sampling.

UCMR 4

Under the UCMR program, EPA asks large systems to monitor once every five years for a list of no more than 30 unregulated contaminants. There is one tier of contaminants in UCMR4; List 1 - Assessment Monitoring. All systems serving more than 10,000 persons were required to monitor for 10 List 1 cyanotoxins during a 4-consecutive month period from March 1, 2018 and November 31, 2020. All system serving more than 10,000 persons were also required to monitor for 20 List 1 additional contaminants during a 12-month period between January 1, 2018 and December 31, 2020. The 20 List 1 additional contaminant consist of metals, pesticides, HAA, alcohols, semivolatile chemicals, and indicators.

The City collected samples for UCMR 4 in 2018. No detections of chemicals in the lists were observed.

UCMR 5

On December 17, 2021, the EPA executed the final "Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 5) for Public Water Systems" and the rule was subsequently published in the Federal Register on December 27, 2021 (86 FR 73131). The 5-year UCMR 5 cycle spans 2022 – 2026, with preparations in 2022, sample collection from 2023 – 2025, and completion of data reporting in 2026.

UCMR 5 specifies monitoring for 29 per- and polyfluoroalkyl substances and lithium. As a groundwater system, the City must collect samples two times during a consecutive 12-month monitoring period with sample events occurring five-to-seven months apart.

The City is planning to begin sampling in 2023.

8.3.7. PFAS Rule

Per- and polyfluroalkyl substances (PFAS) are a large family of chemical in use since the 1950s to make a wide variety of stain-resistant, water resistant, and non-stick consumer products. PFAS also have many industrial uses because of their special properties. In Washington State, PFAS have been used in certain types of firefighting foams utilized by the U.S. military, local fire departments, and airports.

The State Board of Health revised the Group A drinking water rules in 2022 to require water systems to monitor for select PFAS compounds. The new rule establishes state action levels (SAL) for five PFAS compounds. Systems with a PFAS sample result that exceeds a SAL should collect a confirmation sample. If the average of the results of the initial and confirmation samples exceed the SAL, or if the system doesn't collect a confirmation sample, the system must notify its customers of the SAL exceedance event. The SALs can be reviewed on the DOH website.

Water systems will be required to monitor for PFAS beginning January 2023 through December 2025. Each water system's Water Quality Monitoring Schedule will list the PFAS monitoring requirement starting in 2023. The frequency of monitoring will be based on the results of the first sampling events per the guidance in DOH publication 331-668: PFAS Monitoring and Follow Up Actions.

The State's PFAS rule require monitoring during the same timeframe as the recently promulgated UCMR 5. Therefore, the City will conduct monitoring for this rule coincident with UCMR 5 monitoring which will begin in 2023. The City is actively developing its communications plan for customers regarding PFAS, regulatory requirements, and upcoming sampling.

8.4. Distribution System Regulations

This section summarizes effective water quality regulations pertaining to the distribution system. A discussion of each rule follows.

8.4.1. Lead and Copper Rule

Lead and copper are metals that may be found in household plumbing materials and water service lines. Lead can cause a variety of negative health impacts, including delaying physical and mental development in infants and children. Copper can cause aesthetic issues in addition to short-term and long-term negative health impacts. The Lead and Copper Rule (LCR) establishes action levels, monitoring, and compliance requirements for lead and copper levels at customers' taps. To meet the established action levels, 90 percent of all samples must have lead levels equal to or less than 0.015 mg/L and copper levels equal to or less than 1.3 mg/L. If these action levels cannot be met, systems must implement public education and a corrosion control treatment strategy for meeting these levels.

The EPA initiated a review of the LCR implementation across the nation in 2004, which resulted in revisions to the LCR. This effort was focused on determining whether national lead levels are

increasing in the US. As a result of this effort, the EPA identified several targeted changes to the existing regulation that would meet short-term goals for improving implementation of the Lead and Copper Rule. These revisions were finalized in October 2007 and became effective in December 2007.

The short-term revisions were intended to enhance implementation of the Lead and Copper Rule in the areas of monitoring, treatment, customer awareness, and lead service line replacement. Additionally, these revisions focus on improving compliance with public education requirements of the Lead and Copper Rule to ensure that consumers receive meaningful and timely information that assists in limiting exposure to lead in drinking water. CO2 stripping is provided at the City's wells to increase pH for corrosion control, except at Well No. 4 where sodium hydroxide is used. Redmond does not participate in Seattle Public Utility's Regional Monitoring Program for Lead and Copper. Redmond is in compliance with the Lead and Copper Rule and is on a DOH-approved reduced monitoring schedule for lead and copper. The City is required to collect a minimum of 50 samples once every three years. Sampling occurred in 2018 in accordance with DOH requirements. No exceedances were observed in sampling events throughout the prior planning period through June 2021.

The EPA promulgated further revisions to the LCR in 2021. The goals of the rule revisions are:

- Provide greater and more effective protection of public health
- Better identify high levels of lead
- Improve reliability of lead tap sampling results
- Strengthen corrosion control treatment (CCT) requirements
- Expand consumer awareness
- Improve risk communication
- Accelerate lead service line replacement (LSLR)

The rule revision mostly focuses on lead. The rule incorporates a trigger level for lead of 0.010 mg/L liter (90th percentile). A sample at this concentration triggers additional planning, monitoring, and treatment requirements.

A key focus of the revisions are lead service lines (LSLs). The rule requires water systems to inventory their LSLs and establish an LSL removal plan (or demonstrate the absence of LSLs) within three years of rule publication (October 16, 2024). The inventory must be updated annually and made publicly available. The results of lead monitoring determine the rate at which the utility must replace LSLs:

- If P90 > 15 ug/L, the system must replace 3% of LSLs per year based on a 2-year rolling average for at least 4 consecutive 6-month monitoring periods
- If P90 > 10 ug/L to 15 ug/L, LSL replacement goals will be developed in consultation with the regulatory agency for two consecutive 1-year monitoring periods

The rule contains guidance on how these plans should be developed. These regulations also affect priorities for sample collection. More information about the LCR can be found on the EPA website: EPA - Lead and Copper Rule

The City is in contact with DOH concerning guidance on meeting the new requirements, particularly concerning testing in schools and completing the required service line survey. The City will begin planning how to execute the service line survey using the EPA's guidance for compliance with the revised rule. The City is actively developing its communications plan for customers regarding the LCR. DOH continues to discuss and develop guidance on meeting the

requirements of the rule and the City will implement guidance practices as they become available.

8.4.2. Total Coliform Rule

The Total Coliform Rule (TCR) requires water systems to monitor their distribution system for the presence of coliform bacteria, which is a surrogate used to indicate treatment effectiveness, distribution system integrity, and possible contamination of fecal origin. The City performs monitoring as outlined in its existing *Coliform Monitoring Plan*. Monitoring is required at representative sites on a monthly basis, with the sample quantity dependent on the size of the population served. All samples testing positive for total coliform must be followed by repeat sampling and additional testing to determine if *E. coli* is present.

Under the TCR, there are two types of violations: acute and non-acute. An acute MCL violation for coliform is based on the presence of either fecal coliform or *E. coli* in a repeat sample, or coliform presence in a repeat sample collected as a follow-up to a sample indicating the presence of fecal coliform or *E. coli*. A non-acute MCL violation for coliform occurs under the following conditions applicable to Redmond: a system that collects 40 or more coliform samples per month (corresponding to a service population of at least 33,001) has more than 5% of the routine samples taken in one month test positive for the presence of total coliform.

The EPA published the Revised Total Coliform Rule (RTCR) in February 2013 with minor corrections in February 2014. The RTCR is the revision to the 1989 Total Coliform Rule (TCR) and is intended to improve public health protection. Provisions of the RTCR include:

- Setting a maximum contaminant level goal (MCLG) and maximum contaminant level (MCL) for E. coli for protection against potential fecal contamination.
- Setting a total coliform treatment technique (TT) requirement.
- Requirements for monitoring total coliforms and E. coli according to a sample siting plan and schedule specific to the PWS.
- Provisions allowing PWSs to transition to the RTCR using their existing TCR monitoring frequency, including PWSs on reduced monitoring under the existing TCR.
- Requirements for seasonal systems to monitor and certify the completion of state-approved start-up procedures.
- Requirements for assessments and corrective action when monitoring results show that PWSs may be vulnerable to contamination.
- Public notification (PN) requirements for violations.
- Specific language for CWSs to include in their Consumer Confidence Reports (CCRs) when they must conduct an assessment or if they incur an E. coli MCL violation.

The City of Redmond is in compliance with the Total Coliform Rule and WAC 246-290-300(2). The City collects at least 100 routine coliform samples per month at locations throughout the system, as well as entry-point chlorine sampling each day that routine or repeat samples are collected.

The City has observed several instances of coliform detections over the prior planning period, listed below:

- Jan. 6, 2010 – Total Coliform Detection
- Oct. 5, 2010 – Total Coliform
- Aug. 15, 2012 – Total Coliform
- May 30, 2013 – Fecal Coliform and Total Coliform

No follow-up samples showed presence of coliforms.

The City will regularly review and update the Coliform Monitoring Plan to reflect population changes and monitoring requirements. The most recent Coliform Monitoring Plan is in Appendix G.

8.4.3. Surface Water Treatment Rule

The SWTR requires a minimum disinfectant residual of 0.2 mg/L at the point of entry to the distribution system at all times. Additionally, a detectable disinfectant residual must be present in at least 95% of all distribution system samples collected at the same time and location as coliform samples per WAC 246-290-451. Alternatively, samples may be analyzed for heterotrophic bacteria. A heterotrophic bacteria level of 500 colony forming units per milliliter (cfu/mL) or less is considered equivalent to a detectable disinfectant residual.

Though the City does not divert and treat surface water, the City collects chlorine residual measurements daily and at the same time and location as routine and repeat coliform samples.

8.4.4. Stage 1 Disinfectants/Disinfection By-Products Rule

Disinfection by-products (DBPs) result from the reaction of natural organic matter (NOM) and various inorganic precursors with chemical disinfectants. Toxicological research has shown that many DBPs have carcinogenic and other adverse properties when ingested over long periods of time. In 1979, the EPA enacted the Total Trihalomethane Rule, which set an interim MCL for total trihalomethanes (TTHM) of 0.1 mg/L as a running annual system-wide average based on quarterly monitoring within the distribution system. This rule applied to water systems using a chemical disinfectant and serving over 10,000 customers.

In 1998, the EPA promulgated the Stage 1 Disinfectants/Disinfection By-Products (D/DBP) Rule to further reduce the DBP levels in drinking water. The Stage 1 D/DBP Rule became effective in January 2002 for large systems (those serving 10,000 or more people) and January 2004 for small systems (those serving less than 10,000 people). The Stage 1 D/DBP Rule established new MCLs for chlorite, bromate, and the sum of five haloacetic acids (HAA5) (0.060 mg/L), and established maximum residual disinfection levels (MRDLs) for chlorine (4.0 mg/L), chloramines, and chlorine dioxide. It also lowered the MCL for TTHM (0.080 mg/L) and set total organic carbon removal requirements for systems using conventional filtration.

DOH directed Redmond to test for TTHM and HAA5 at five locations per quarter within the groundwater system and the Novelty Hill (or Redmond Ridge) system. The system has four groundwater plants (Wells 1&2, Well 3, Well 4, and Well 5). Wells 1 and 2 are 130 feet apart, draw from the same aquifer, are blended prior to distribution, and therefore considered to be one plant.

Results for samples collected in 2009 at points of entry and various locations in the Redmond distribution system yielded TTHM levels ranging from 0.007 to 0.041 mg/L and HAA(5) levels ranging from <0.005 to 0.036 mg/L. These results are less than the MCLs.

8.4.5. Stage 2 Disinfectants/Disinfection By-Products Rule

The Stage 2 DBP Rule was published in the Federal Register on January 4, 2006. The rule was developed to provide more equitable protection against DBPs on a system-wide basis by changing the compliance monitoring provisions. The Stage 2 DBP Rule applies to water

systems that serve drinking water treated with a primary or secondary chemical disinfectant. The Stage 2 DBP Rule does the following:

- Changes the method of calculating DBP regulatory compliance to a locational running annual average (LRAA) of quarterly samples, in which the system calculates a running annual average for each DBP monitoring location instead of calculating a running annual average for the entire system.
- Changes the location and number of DBP monitoring sites. The rule requires systems to conduct an Initial Distribution System Evaluation (IDSE) to select Stage 2 DBP monitoring locations in areas of the distribution system with elevated DBP levels. Additionally, the final Stage 2 DBP Rule requires systems to determine monitoring requirements based on population.
- Establishes DBP operational evaluation levels for each monitoring site which are calculated as 25% of the sum of the two previous quarter's results plus twice the current quarter's monitoring result. A system that exceeds this level is required to conduct an operational evaluation, i.e., evaluating their distribution system operations to determine ways to reduce DBP levels. The system is required to notify the state of an operational evaluation level exceedance and submit evaluation results within 90 days of the exceedance.
- Consecutive systems that purchase drinking water carrying a disinfectant are required to implement Stage 2 DBP requirements on the same schedule as the largest water system in their combined distribution system.

The first step in complying with the Stage 2 DBP Rule was to conduct an IDSE. The goal of the IDSE is to identify areas that have routinely higher DBP concentrations than other areas in the distribution system and use this information to select monitoring locations for long-term Stage 2 DBP compliance monitoring.

Redmond was required to complete a Standard Monitoring Plan by October 1, 2006. This plan was approved by EPA and Redmond began sampling per the Standard Monitoring Plan in October 2007. After completing one year of sampling, Redmond developed an IDSE Report, which summarized the IDSE sample collection results plus Stage 1 DBP monitoring that occurred during the IDSE period, and recommended routine Stage 2 DBP monitoring locations. The IDSE Report was completed by January 1, 2009. Routine monitoring for DBPs at eight selected sites (selected per the protocol described in the Stage 2 Rule) began on April 1, 2012.

The City collects eight quarterly samples for THMs and HAA5s. The City has not had any exceedances for disinfection by-products. The City's DBP monitoring plan is in Appendix H.

8.4.6. Asbestos Rule

Asbestos monitoring is required as part of the Inorganic Monitoring under the Phase II Rule. Distribution system monitoring for asbestos is also required if a distribution system contains more than 10% asbestos-cement (AC) pipe. Systems with AC pipe must sample the distribution system at a tap served by the AC pipe and under conditions where contamination is most likely to occur. Monitoring under the asbestos rule is required once per nine years unless a sample exceeds the MCL of 7 million fibers per liter.

The City has a standard nine-year monitoring requirement. The City most recently sampled for asbestos in 2018 and will sample again in August 2027. The City has not detected asbestos during any sampling event.

8.5. Other Water Quality Regulations

This section summarizes other effective water quality regulations applicable to the City. A discussion of each rule follows.

8.5.1. Consumer Confidence Reports and Public Notification Rule

Under the Consumer Confidence Report (CCR) Rule promulgated in 1998, water systems are required to provide an annual CCR on the source of their drinking water and levels of any contaminants found. The City produces an annual water quality report that meets these requirements; the most recent report is in Appendix I. The annual report must be supplied to all customers and must include:

- Information on the source of drinking water;
- A brief definition of terms;
- If regulated contaminants are detected, the MCLG, MCL, and the level detected;
- If an MCL is violated, information on health effects; and
- If EPA requires it, information on levels of unregulated contaminants.
- Minimum requirements of the contents of the report per WAC 246-290-72001.

While the CCR provides annual "state-of-the-water" reports, the Public Notification Rule (PNR) directs utilities in notifying customers of acute violations when they occur. The PNR was revised in May 2000 and outlines public notification requirements for violations of MCLs, treatment techniques, testing procedures, monitoring requirements, and violations of a variance or exemption. Notification requirements are briefly summarized herein:

IOC/VOC/SOC Reporting Procedures

If routine sampling indicates a violation of primary or secondary MCL violation, then the water purveyor must collect confirmation sample(s), remove the source from service, and report the violation to DOH within 24 hours. If DOH determines the violation poses an acute health effect, then the purveyor must provide notice of the violation to water customers within 24 hours of the violation. If it is determined that the violation does not pose an acute health risk, then the purveyor must mail a notice to customers within 30 days.

Bacteriological Reporting Procedures

If bacteriological presence is detected in a routine sample, the following reporting requirements will take effect:

- Each total coliform-positive routine sample must be tested for the presence of E. coli.
- If fecal coliform or E. coli is detected in routine sample, the City is required to notify DOH by the end of the day that the PWS is notified.
- Within 24 hours of learning a total coliform-positive sample result, at least three repeat samples must be collected and analyzed for total coliform.
- If one or more repeat sample is coliform-positive, the sample must be analyzed for the presence of E. coli. If the repeat sample is also E. coli-positive, the sample result must be reported to the state by the end of the day the PWS is notified.

Unregulated Contaminant Reporting Procedures

Reporting procedures for unregulated contaminants are similar to the reporting requirements for IOCs, VOCs, and SOCs. If the unregulated contaminant has a proposed MCL, then the reporting requirements are the same as those stated for IOCs, VOCs, and SOCs. If a detected unregulated contaminant does not have a proposed MCL, DOH must be contacted, and DOH will determine the reporting procedures.

8.5.2. Operator Certification

The 1996 SDWA amendments require that states develop and implement an operator certification program. The regulation sets out minimum guidelines for such a certification program including operator classification and qualifications. These sections of the regulation require that:

- Each treatment facility and/or distribution system be placed under the direct supervision of a certified operator;
- Operator certification must be equal to or greater than the system classification being operated;
- All process control personnel must be certified;
- At least one certified operator be available on every shift;
- Operators must sit for, and pass, a validated exam demonstrating skills, knowledge, ability, and judgment necessary for the system classification; and
- Each operator has a high school diploma, GED, or State approved experience and training.

While the responsibility for developing the program lies with DOH, systems such as Redmond are required to bring all operators up to the level of certification as required.

Redmond satisfies EPA and DOH operator certification requirements. As discussed in Chapter 11, all water system supervisor and technicians have the appropriate water certification from DOH.

8.6. Anticipated Future Regulations

Anticipated future regulatory requirements are summarized in Table 8-2. This table includes ongoing programs to introduce new regulatory requirements, under the Unregulated Contaminant Monitoring Rule and the Contaminant Candidate List, as well as specific rules and regulations currently under consideration. A brief description of anticipated requirements under each rule is provided herein.

Table 8-2. Anticipated Future Regulations

Proposed Rule	Affected Contaminants	Proposed Publication Date [a]
PFAS	Potential future requirements for monitoring PFAS and PFOA	2023

[a] Effective and compliance dates were obtained from the Federal Register and EPA's Drinking Water Website and represent the best information available as of the date of this report.

8.6.1. Per- and Poly-Flouroalkyl Substances (PFAS)

Under the SDWA, EPA has the authority to set enforceable National Primary Drinking Water Regulations (NPDWRs) for drinking water contaminants and require monitoring of public water supplies. To date, EPA has regulated more than 90 drinking water contaminants but has not established national drinking water regulations for any PFAS. In March 2021, EPA published the Fourth Regulatory Determinations, including a final determination to regulate Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonic acid (PFOS) in drinking water. The Agency is now developing a proposed NPDWR for these chemicals. As EPA undertakes this action, the Agency is also evaluating additional PFAS and considering regulatory actions to address groups of PFAS. Recent additions of PFAS chemicals considered for regulation include GenX Chemicals and PFBS.

In July 2022, the EPA issued health advisories for two PFAS molecules, GenX Chemicals and PFBS. The current health advisories issued by the EPA for PFAS are:

- PFOA – 0.004 ppt
- PFOS – 0.02 ppt
- GenX Chemicals – 10 ppt
- PFBS – 2,000 ppt

The Agency anticipates issuing a final regulation in Fall 2023 after considering public comments on the proposal. Going forward, EPA will continue to analyze whether NPDWR revisions can improve public health protection as additional PFAS are found in drinking water.

8.7. Laboratory Certification

Redmond uses five certified laboratories for sample analysis. The laboratories and their contact information are listed below.

Am Test Inc.
13600 NE 126th PL
Suite C
Kirkland, WA 98034
Phone: 425-885-1664

Edge Analytical Laboratories
11525 Knudson Road
Burlington, WA 98231
Phone: 1-800-755-9295

City of Seattle Public Utilities
Water Quality Laboratory
800 South Stacy Street
Seattle, WA 98134

Anatek Labs Inc
1282 Alturas Dr
Moscow, ID 83843
Phone: 208-883-2839

OnSite Environmental Inc
14648 NE 95th St
Redmond, WA 98052
Phone: (425) 883-3881

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Chapter 9: Wellhead Protection Program

City of Redmond 2023 Water System Plan DRAFT

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9. Wellhead Protection Program

The City operates five shallow groundwater wells that deliver between 2.6 and 2.9 million gallons of water per day, comprising approximately 40 percent of the City's total drinking water supply. The wells withdraw water from a shallow alluvial aquifer and are located within Redmond's downtown and industrial areas. Therefore, the wells are susceptible to contamination based on the local hydrogeologic conditions and the proximity of potential pollution sources.

In response to this situation, the City has developed a comprehensive wellhead protection program (WHPP), also referred to as the groundwater protection program, to protect its groundwater supplies. The program was developed in accordance with the regulations of WAC 246-290-135. It includes multiple elements to protect the City's groundwater sources.

This chapter provides a history of the wellhead protection program, followed by a summary of key program elements and current activities. The chapter concludes with an assessment of the program's compliance with DOH regulations, and a description of future activities.

9.1. Background and History

In the early 1950s, the City began using groundwater as a source of supply, replacing its previous, unreliable surface water supply. Presently, five groundwater wells generally serve the portion of the City located east of the Sammamish River, while water obtained from the regional water transmission system of Seattle Public Utilities (SPU) serves the area west of the river and the Novelty Hill Service Area that lies several miles east of the City. For further information on areas served by these sources, see Chapter 3.

The shallow aquifer tapped by the wells is a highly permeable layer of sand and gravel located in the lower Bear Creek and Sammamish River Valleys. Due to the wells' high susceptibility to contamination, the City has developed a robust wellhead protection strategy. Key milestones in the history of the City's WHPP are summarized below.

- 1997. The City prepared and submitted to DOH a Wellhead Protection Report, with funding support from the State of Washington. The report provides:
    - A detailed description of the hydrogeologic setting of the City's groundwater sources.
    - Initial delineation of the groundwater time-of-travel zones for each well, based upon computer modeling.
    - An inventory of potential contaminant sources and an assessment of risk to groundwater supplies.
    - A water supply contingency plan.
    - A spill response plan.
    - Public education and involvement programs.
    - Strategies and actions for future implementation.
- 1999. The City Council adopted the *Wellhead Protection Report* and authorized the development of a wellhead protection ordinance.
- 2003. The City Council adopted the wellhead protection ordinance. The ordinance established wellhead protection zones, based upon the time-of-travel zones identified in the *Wellhead Protection Report*. All areas within the ten-year time-of-travel zones for all

public water sources owned by the City are designated as critical aquifer recharge areas under the provisions of the Growth Management Act. Details of the regulations, programs, and enforcement mechanisms established by the ordinance are documented in Chapter 13.07 of the Redmond Municipal Code.

- 2005. Wellhead protection program implementation planning continued. Key items addressed included:
    - Definition of roles of City departments in wellhead protection.
    - Identification of actions to address deficiencies in the existing management framework.
    - Development of protocols for interdepartmental and interdivisional communication.
    - Development of a framework for a monitoring program.
    - Identification of resources needed to support the program.
    - Establishment of a technical assistance program to assist residents, businesses, and organizations in complying with the ordinance.
    - Development of key program strategies to guide the establishment of program components, standards, and best management practices required by the ordinance.
- 2008. The *Sampling and Analysis Plan (SAP)* was developed, describing the detailed procedures used to implement the groundwater monitoring program. Semi-annual groundwater monitoring commenced. An environmental database was built to house the data generated.
- 2008 and 2010. Ordinances were passed to update the requirements for registering, assessing and modifying stormwater infiltration systems that may present a risk to the groundwater resource. The majority of the 100 facilities identified as moderate or high risk to groundwater have been retrofitted to ensure groundwater is protected.
- 2011. Redmond entered into the Local Source Control Inter-Agency Agreement (IAA), now known as the Pollution Prevention Assistance IAA, with Ecology. This IAA provides annual funding for City staff to conduct technical assistance visits at businesses that store hazardous materials. Staff provide businesses with tools to properly store the hazardous materials and ensure surface water and groundwater are protected.
- 2016. Ordinance 2831 was passed adopting RMC 13.25 (Temporary Construction Dewatering). The code provides the City with options to prevent, limit, and respond to dewatering activities that impair the City's ability to deliver drinking water from the City water supply wells, safely convey and treat storm water runoff within the City's municipal separate stormwater sewer system and private storm water systems, and manage the movement and disposal of contaminated groundwater.
- 2016. Redmond code was analyzed for barriers to Low Impact Development (LID) to ensure LID is the preferred and commonly used approach to site development. City staff annually review proposed code changes to ensure this goal is continually met. In the Critical Aquifer Recharge Area (CARA), LID is only available for infiltration of non-pollution generating surfaces.
- 2019. Updates to RMC 13.07 (Wellhead Protection) were adopted by Redmond City Council. Key items included in the update were:

    - Updated wellhead protection areas using a three-dimensional groundwater flow model informed by best available science (Figure 9-1). The updated wellhead protection areas were used to establish the CARA. CARA delineations were informed by stakeholder input and included a buffer to account for impacts from

temporary construction dewatering. Figure 9-2 displays the full CARA that extends beyond the City limits into unincorporated King County.
    - Restricted reclaimed water use within the CARA.
    - Improved risk reduction to groundwater due to high risk activities such as fueling facilities. Changes include tertiary containment of tanks pits for new development and annual tank tightness tests for aging underground storage tanks.
- July 2019. City of Redmond Groundwater Quality Assurance Program Plan was developed. This document focused on supporting investigations for Redmond's Wellhead Protection Monitoring Program.
- 2020. Policy recommendations resulting from the temporary construction dewatering (TCD) triple bottom line analysis was accepted by Council. Staff are currently working to implement these recommendations.
- 2022. Ordinance 3093 was adopted by Council. This amendment to RMC 13.25 (Temporary Construction Dewatering) added limitations to dewatering to the rate, duration, and depth of dewatering within the CARA.

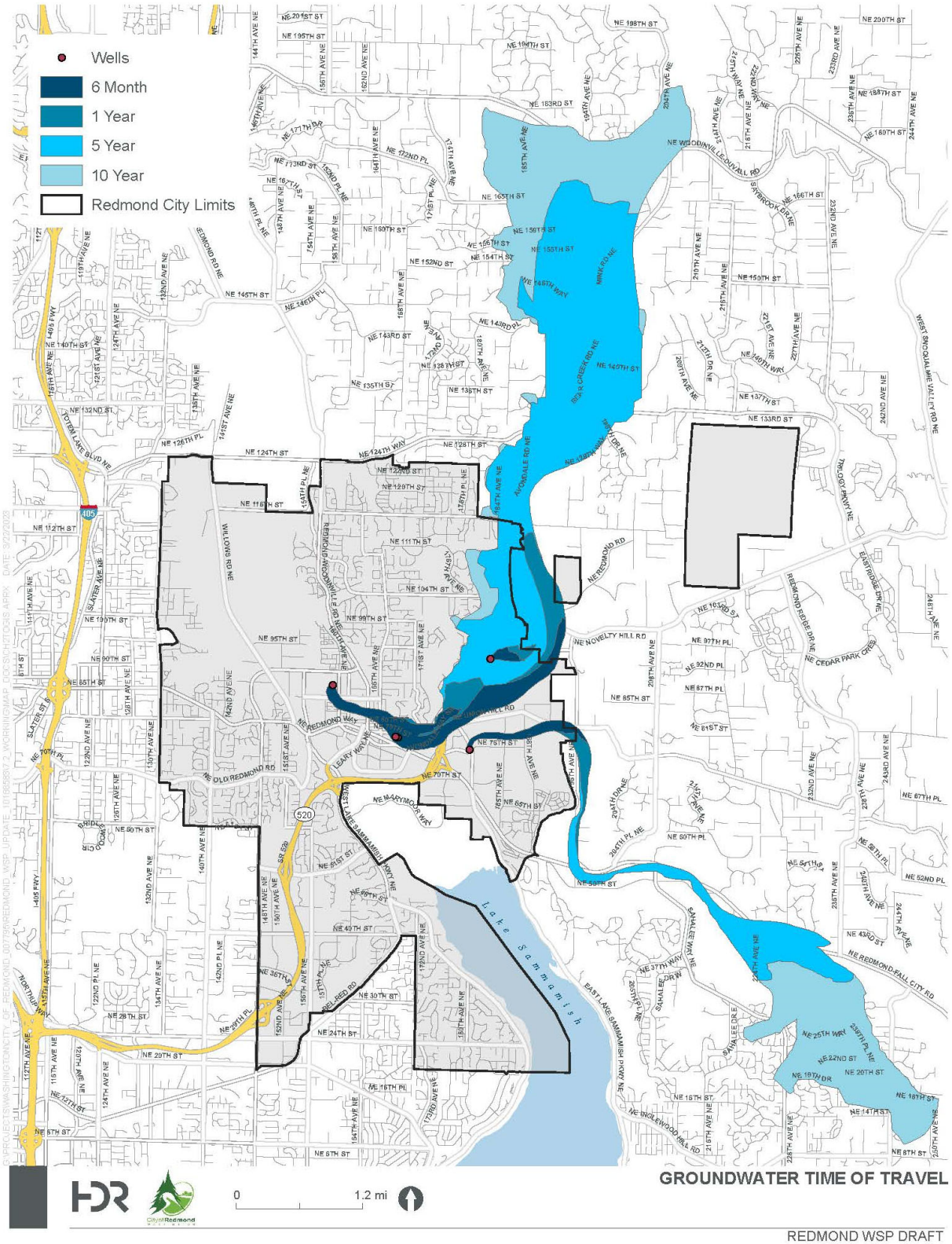

Figure 9-1. Wellhead protection time of travel zones

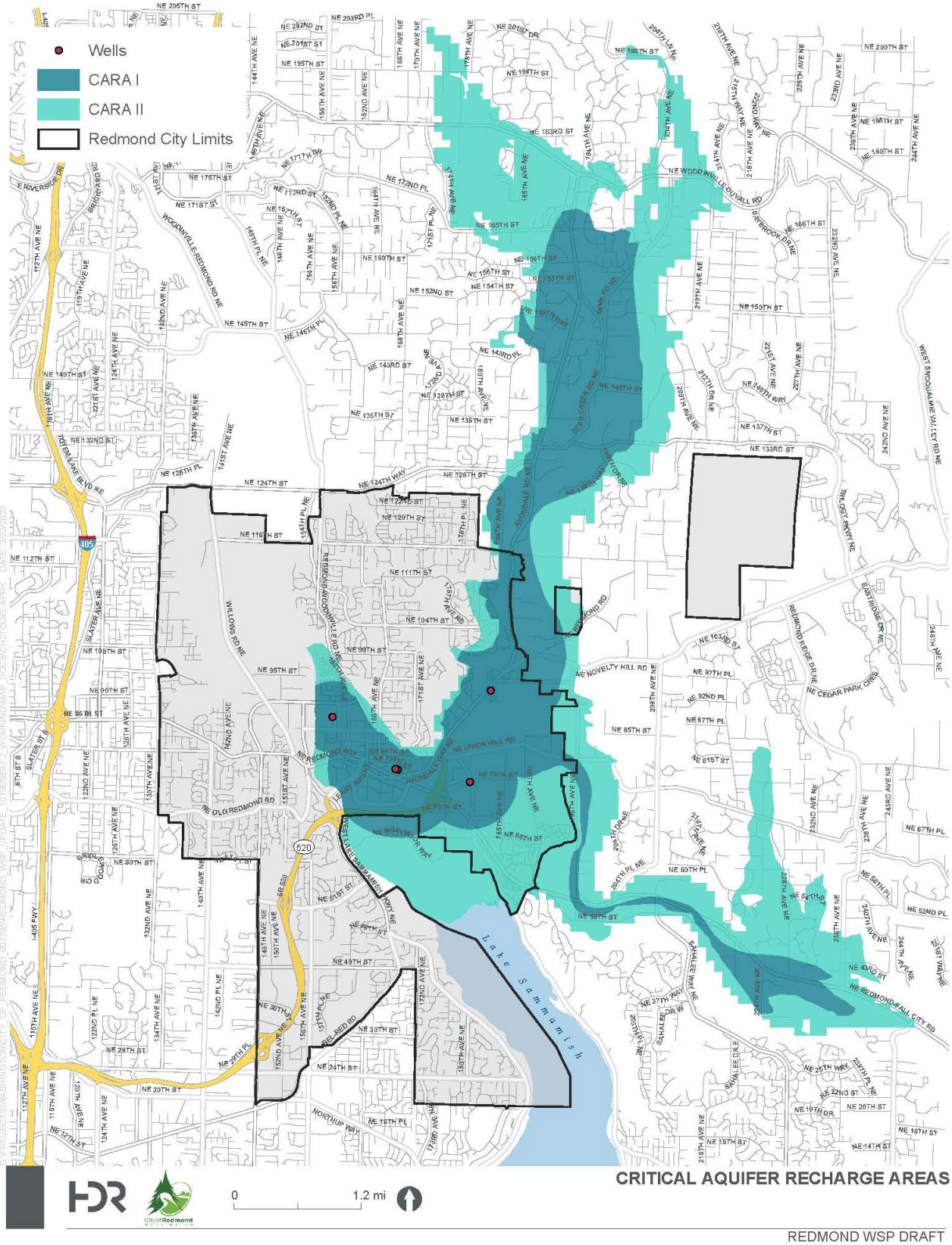

Figure 9-2. Critical Aquifer Recharge Areas

9.2. Key Program Elements and Current Activities

The City's WHPP is a multi-faceted program, with a range of programs and activities that together protect the City's groundwater sources. The primary elements of the program are described below. Additional detail is provided in WHPP working documents, which are on file at the City.

9.2.1. Groundwater Monitoring Program

The objective of the groundwater monitoring program is to serve as an early warning system for Redmond's drinking water supply wells. The groundwater monitoring program identifies potential contaminants in the groundwater so Redmond can take action before they reach a supply well. Additionally, the City tracks declines in water table levels. The program's objective is accomplished through utilization of an integrated network of monitoring wells to track the movement of groundwater and degraded water quality (ex. potential contaminants) within the City's Critical Aquifer Recharge Area (CARA), shown in Figure 9-2. Approximately 90 groundwater monitoring wells, the majority of which are located within the CARA, are maintained by the City. In addition to the city-owned monitoring network, Groundwater Protection staff have access agreements for several privately-owned wells that can be monitored for water level measurements. These agreements are cost-effective for the City to help fill data gaps.

The first complete sampling event occurred during early 2007. The monitoring wells are sampled on a semiannual basis. During each event, field staff take water level measurements at all monitoring wells. In addition, the following water quality parameters are evaluated at approximately 25 of the wells: pH, temperature, dissolved oxygen, oxidation-reduction potential, turbidity, specific conductivity, metals; volatile organic compounds (VOCs); fluoride, chloride, sulfate, nitrate (as N); bicarbonate; and total dissolved solids. Select wells may be sampled for additional analytes, including coliform bacteria, hydrocarbons, total organic carbon, phosphate, semi-volatile organic compounds, herbicides (including glyphosate), pharmaceuticals and personal care products, and per- and polyfluoroalkyl substances.

Groundwater data collected from sampling events and historic third-party information is stored and organized in a combination of the city's environmental database and electronic and paper files. Currently the City is using the EQuIS software application as its central repository for city collected data. Use of the database facilitates expanded analysis and water resource protection and assists with fulfilling public records requests. Data are analyzed to determine trends, develop relationships, and evaluate the condition of the aquifer.

The groundwater monitoring program allows the City to better understand the groundwater flow regime and groundwater interaction with surface water, track contaminant plumes, track potential water level and quality impacts from temporary construction dewatering pumping, and monitor cleanup efforts. It also supports evaluation of the effectiveness of the WHPPs' hazardous materials management processes and helps determine locations for additional monitoring wells in the future.

9.2.2. Contamination Reporting, Response, & Clean Up

Groundwater Protection staff collect and review data on investigation and cleanup activities and provide third party oversight of these activities in coordination with the Washington State

Department of Ecology (Ecology) and other agencies and city departments or divisions, to the extent necessary and practical. Owners or operators of facilities involved with a contamination event are required by code to provide notice to the City at the same time such an event is reported under either Ecology's Model Toxics Control Act (MTCA) cleanup regulations or the U.S. Environmental Protection Agency's (USEPA's) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Notice must also be provided to the City within five days of receiving notification from Ecology or the USEPA that cleanup has been finished and no further actions are required.

9.2.3. Public Outreach, Technical Assistance, and Inspection Program

The City has established a public outreach program to inform customers and the general public about the City's wellhead and groundwater protection efforts and to provide avenues by which the public can contact City staff in order to obtain more information. The program involves the City's web page (www.redmond.gov/groundwater) and social media, articles in local periodicals, newsletters, and newspapers, and direct mailings to facilities. The web page provides background on the wellhead and groundwater protection program, maps, the wellhead protection municipal code, staff contact information, and links to related federal, State, and local programs.

City technical assistance and inspection programs provide stormwater and groundwater pollution prevention at sites Citywide, with additional emphasis placed on sites within the CARA. City Environmental Programs staff identify these sites during the business license review process, collecting information on hazardous materials use, storage, handling, and disposal. Businesses that handle hazardous materials are identified, evaluated, and assigned a reoccurring inspection frequency based upon the site's potential pollution risk.

Redmond Municipal Code 13.07 (Wellhead Protection) authorizes the City to inspect sites to determine compliance with City requirements. Inspections may include visual evaluation, inspections of hazardous materials storage and disposal, and sampling of soils, surface water, and groundwater at the site. In addition, the City encourages sites to minimize pollution risks by reducing hazardous materials quantities stored on-site, placing hazardous materials in secondary containment, and improving spill preparedness and spill response capabilities.

The City technical assistance and inspection programs have conducted 2,723 inspections from 2008 – 2022 throughout the City. As a result of these inspections:

- 66,106 gallons of hazardous materials have been secondarily contained.
- 18,509 gallons of hazardous materials have been removed from sites.
- 187 spill kits have been distributed.
- 33 containment pallets of secondary containment have been distributed.

9.2.4. Development Review and Capital Improvements

Groundwater Protection staff provides review of development and construction activities within the CARA, to ensure performance standards are met and to prevent activities that may

potentially impact groundwater resources. Project plans and documents are reviewed to ensure that regulatory requirements are adhered to and groundwater resources are considered during development review, tenant improvement and building permitting, construction and property acquisitions.

9.2.5. Stormwater Infiltration

This element of the WHPP involves review of the City's stormwater systems, private and public, to identify discharges of stormwater from pollution-generating surfaces into groundwater infiltration systems. The City has coordinated its stormwater infiltration modification program with the State's underground injection control (UIC) registration and retrofitting program. Assessments have been completed at the 100+ known infiltration facilities in the CARA. Most facilities that were identified as being a risk to groundwater have either been redeveloped and or will soon be redeveloped and brought up to current standards, which protects groundwater. Thirteen facilities have retrofitted their stormwater infiltration system and one facility is currently in the process of updating their stormwater infiltration system to protect groundwater. Three facilities, two of which are owned by the same entity, still need to be addressed.

9.3. Compliance with Source Water Protection Regulations

WAC 246-290-135 requires that the specific elements listed below be included in a WHPP. The various program elements, activities, and documents described above fulfill these source protection requirements.

9.3.1. Susceptibility Assessments

Assessments of the susceptibility of the City's well sources to contamination are included in Chapter 6 of the 1997 *Wellhead Protection Report*. This section of the report inventories potential groundwater contamination sources and prioritizes contaminant risks to groundwater in the wellhead protection zones. In 2018 a groundwater model was used to update the time of travel zone (also referred to as wellhead protection zones). An updated susceptibility evaluation is included in Appendix A of the Analysis of Groundwater Supply Protection Measures in the City of Redmond, Washington (March 2018).

9.3.2. Wellhead Protection Area Information

Chapter 4 of the 1997 *Wellhead Protection Report* and Chapter 2 of the 2018 Groundwater Flow Model Development Report provide a detailed description of the hydrogeologic setting of the City's groundwater sources. Wellhead protection zones were first delineated in the *Wellhead Protection Report* and have been subsequently updated in 2018. These updated areas were used to delineate the CARA. Current maps of the CARA are shown in Figure 9-2. Figure 9-1 depicts the current delineation of the protection, or time of travel, zones.

The land uses within the wellhead protection zones have not significantly changed since the writing of the *Wellhead Protection Report* and the *Analysis of Groundwater Supply Protection Measures.* However, the intensity of land use has increased. The area near Wells 1, 2 and 3 have become more dense, with mixed-use residential buildings being the majority of the development. The land near Well 5 has seen increases in the amount of commercial and

industrial land uses. As a result, recent outreach, education, technical assistance, and pollution prevention efforts have been focused within the Wells 1, 2, 4 and 5 time of travel zones, and within the CARA as a whole.

Another change that has occurred within the wellhead protection area in the past decade is the transition of some areas (e.g., along Union Hill Road and in the east Redmond industrial area) from septic systems to sewered wastewater collection. This change provides improved protection to the City's groundwater sources. The redevelopment occurring near Wells 1, 2, 4, and 5 have resulted in historic infiltration systems being updated to current standards, reducing the risk to groundwater. Redevelopment has also resulted in historical contaminated sites being remediated. Additionally, LID requirements have resulted in redeveloped properties infiltrating more of their clean stormwater runoff, providing more recharge to the aquifer.

9.3.3. Contaminant Source Inventory

Every two years the City must produce a Contaminant Inventory to meet State requirements. The Inventory must identify the locations of all known and potential groundwater contamination sources located within the CARA having the potential to contaminate the source water of the City's five drinking water wells. The most recent inventory was submitted to DOH in 2021 and contained information provided by Lightbox Environmental Data Resources (EDR), which summarizes data from Federal, State, County, Local, and Tribal records. The City notified the appropriate regulatory agencies, local governments, and local emergency incident responders of the boundaries of the CARA and the findings of the Inventory. The next inventory will occur in 2023 and will be updated every two years per DOH's requirements.

The Contaminant Inventory is mapped by Groundwater Protection staff. This information will drive inspection, technical assistance visits, outreach, future monitoring locations, and clean-up activities.

9.3.4. Notification of Findings

The results of the contaminant source inventory are made available to Redmond residents and businesses through the annual Water Quality Report (also referred to as the Consumer Confidence Report). In 2022 the Water Quality Report included a map of the CARA, a description of the wellhead protection program, and tips of what residents and businesses can do to protect the groundwater. Water Quality Reports on even years have at least one page of the report dedicated to groundwater protection. The City continues public outreach and education through environmental awareness in school programs, adult educational opportunities, and exhibits at local fairs and events.

The City's technical assistance program, described earlier, is an important mechanism by which City staff can communicate with owners and operators of sites and facilities that handle materials that could potentially contribute to groundwater contamination.

9.3.5. Contingency Plan

State requirements specify that water systems using groundwater or springs must have a contingency plan to ensure that customers have an adequate supply of potable water in the event that contamination results in the temporary or permanent loss of the principal source of supply. The City's *Water Shortage Contingency Plan* (May 2009) and *Emergency Response Plan* (September 2020) provide a framework for responding to a loss of primary supply.

In the event that the City's groundwater sources become unavailable, the City can obtain additional water from its connections to Seattle Public Utilities' (SPU's) regional transmission system to meet needs normally supported by the wells.

9.4. Future Activities

The City intends to continue implementation of the key programs and activities described in Section 9.2. Program strategies will be revisited periodically, with modifications made as necessary to guide implementation. Key areas where program focus is anticipated to change include the following:

- *Policy.* Based on the findings from the TCD triple bottom line analysis and policy analysis, City staff have been working to implement policy updates. These updates are occurring through the Redmond Zoning Code ReWrite and Redmond 2050 comprehensive planning processes. Updates to RMC 13.25 (Temporary Construction Dewatering) to restrict TCD within the CARA is anticipated to occur in 2024.
- *Evaluation.* Staff will evaluate new land uses, developments, and construction techniques that could have an impact on groundwater quality or quantity. Issues that have been of recent concern pertain to the shift towards sustainable building including rainwater harvesting, geothermal systems, and grey water systems.
- *Water Conservation.* Redmond staff will conduct a water evaluation to meet the Climate Emergency Declaration adopted by the Redmond City Council on October 6, 2020. The declaration states that Redmond will Increase water conservation practices, reduce water intensity, and implement strategies to minimize use of potable water in municipal operations to achieve a net positive water footprint by 2030.
- *Integrated Pest Management*. Staff have assisted with creation of an Integrated Pest Management Plan for the City. The plan identifies specific pest management practices that should be implemented within the CARA to protect groundwater. The plan is anticipated to be adopted by the Public Works Director in 2024.

Chapter 10: Source, Storage, and Distribution System Analysis

City of Redmond 2023 Water System Plan DRAFT

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10. Source, Storage, and Distribution System Evaluation

10.1. Introduction

This chapter provides an evaluation of the water system's ability to meet current and projected water supply needs of the City's water service area. Source and storage capacity analyses are presented, followed by an evaluation of the distribution system piping network. Required system improvements are also described throughout the chapter.

Throughout this chapter, capacity analyses are presented for 2023 (base year), 2033 (10-year forecast), and 2043 (20-year forecast).

10.2. Source Capacity Evaluation

The source capacity analyses presented in the following sections compare projected demands with current source capacities relative to DOH source capacity requirements. The demands used in this analysis are based on the demand forecast presented in Chapter 4. The total demand for the City Service Area was distributed amongst the Well, Rose Hill, and Overlake service areas based on the average proportion of demands in each service area as recorded in meter data for 2019 – 2021.

DOH requires different analyses for "open" pressure zones (i.e., pressure zones with storage open to the atmosphere) and "closed" zones (i.e., zones without storage where pressure is maintained via pumping). In open pressure zones, sources of supply must be sufficient to meet maximum day demands (MDD). In addition, DOH recommends calculating other supply metrics that evaluate system reliability under various adverse or emergency conditions. This WSP analyzes the following criteria for source capacity, consistent with requirements and recommendations set forth in the DOH 2020 Water System Design Manual:

- Provide maximum day demand with sources operating 24 hours per day (DOH requirement)
- Provide maximum day demand with sources operating 20 hours per day (DOH recommendation)
- Provide average day demand with sources operating 24 hours a day, but with the largest source offline (DOH recommendation)
- Provide maximum day demand while replenishing fire storage over 72 hours (DOH recommendation)

For closed pressure zones, sources of supply must be sufficient to meet peak hour demands (PHD) as well as supply fire flows during MDD conditions. The City analyzed closed zones using a stricter criteria of meeting PHD during fire flow conditions, which exceeds the DOH requirements for closed zones. Since the City is in a public water system coordination act area, the fire flow calculations must be conducted with the largest source out of service.

10.2.1. Well Service Area

Water supply for the Well Service Area is provided by the City's five groundwater wells and two connections to the Tolt 2 Supply Line (Tolt 2), i.e., the NE 172nd Street and NE 104th Street Supply Stations.

In addition, the Well Service Area can receive water from the Rose Hill Service Area through three metered connections located at: 1) Leary Way, 2) NE 90th Street, and 3) NE 85th Street. These supply connections are not included in the source capacity analysis, as they are not used during normal operations.

As summarized in Table 10-1, the combined capacity of the City's wells and Tolt 2 connections exceeds current and future source capacity requirements for the Well Service Area.

Table 10-1. Source Capacity – Well Service Area

Projected ERUs and Demand[1]	Year		
	2023	**2033**	**2043**
Equivalent Residential Units (ERU's)	22,647	26,800	30,797
Average Day Demand (gpd)	3,740,209	4,388,675	5,037,553
Maximum Day Demand (gpd)	9,421,142	11,148,678	12,811,599
Fire Flow Requirement (gpd)	840,000	840,000	840,000
Peak Hour Demand (gpm)[2]	10,551	12,470	14,318
Evaluation of Existing Sources (gpd)			
Available Existing Source [3]			
NE 172nd Street Supply Station (5,000 gpm)[4]	7,200,000	7,200,000	7,200,000
NE 104th Street Supply Station (5,000 gpm)[4]	7,200,000	7,200,000	7,200,000
Wells #1 (900 gpm)[5]	1,296,000	1,296,000	1,296,000
Wells #2 (500 gpm)[5]	720,000	720,000	720,000
Wells #3 (480 gpm)[5]	691,200	691,200	691,200
Wells #4 (400 gpm)[5]	576,000	576,000	576,000
Wells #5 (1,000 gpm)[5]	1,440,000	1,440,000	1,440,000
Total Available Source - 24 hour operation (gpd)	19,123,200	19,123,200	19,123,200
Total Available Source - 20 hour operation (gpd)	15,936,000	15,936,000	15,936,000
Total Available Source - Largest Offline (gpd)	11,923,200	11,923,200	11,923,200
Source Surplus/(Deficiency) (gpd)[6]			
Maximum Day Demand - 24 hour source operation	9,702,058	7,974,522	6,311,601
Maximum Day Demand - 20 hour source operation	6,514,858	4,787,322	3,124,401
Average Day Demand with Largest Source Offline	8,182,991	7,534,525	6,885,647
Fire Storage Replenishment During Max Day Demand[7]	9,422,058	7,694,522	6,031,601

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include all of the Redmond Well Service Area (WSA). ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).
2. Peak hour demand calculated using Equation 3-1 in the 2020 Water System Design Manual, DOH publication 331-123.
3. Sources are assumed to be operating for 24 hours a day.
4. The capacity of the NE 172nd Street and NE 104th Street Supply Stations is each 5,000 gpm as documented in Chapter 3 - System Description.
5. The capacity of Wells #1 - #5 are estimated from Chapter 7 - Source Resource Evaluation. The following flow rates are the maximum permitted pumping rate. Well #1 is 900 gpm, Well #2 is 500 gpm, Well #3 is 480 gpm, Well #4 is 400 gpm, and Well #5 is 1,000 gpm.
6. The DOH requirement is that MDD be met by existing sources operating at 24 hours per day. The other comparisons shown are based on DOH recommendations.
7. Fire storage replenishment assumes 72 hour replenishment period. Fire suppression requirement is 3,500 gpm for 4 hours, or 840,000 gallons.

Within the Well Service Area, water is conveyed amongst multiple pressure zones through Pressure Reducing Valves (PRVs) and pump stations. The distribution system hydraulic analysis discussed in Section 10.4 examines the ability of these facilities to move water as needed to meet system demands.

10.2.2. Rose Hill Service Area

Water supply for the Rose Hill Service Area is provided by three connections to the Tolt Eastside Supply Line (TESSL), i.e., the Rose Hill Supply Stations Nos. 1, 2, and 3. These connections are shared with the City of Kirkland, so the total available source capacity for each source is reduced per the source descriptions in Chapter 3, Table 3-7.

In addition to the demands of the Rose Hill Service Area, water entering this service area may also be conveyed into the Well Service Area (through the three connections noted previously) and into the Bellevue-Overlake-Viewpoint Service Area (through two metered connections, at 156th Avenue NE and NE 51st Street). With the exception of the NE 51st Street connection, none of these connections are used during normal operations. Although the NE 51st Street connection does convey flow from Rose Hill to the 335 pressure zone of Bellevue-Overlake-Viewpoint on a more routine basis, it is assumed to be closed for the purpose of clarity in this source capacity analysis. For consistency, this same assumption is made in the analysis of the Bellevue-Overlake-Viewpoint Service Area, discussed in the following section. The flow of water between these zones was considered in the hydraulic analysis presented in Section 10.4.

As summarized in Table 10-2, the combined capacity of the City's three Rose Hill TESSL connections exceeds current source capacity requirements. On the 20 year planning horizon, sources will be insufficient to meet maximum day demands if operated for only 20 hours a day. This source capacity criteria is a recommendation, not a requirement, and therefore does not represent a deficiency requiring a capital improvement.

Table 10-2. Source Capacity Analysis – Rose Hill Service Area

Projected ERUs and Demand[1]	Year 2023	2033	2043
Equivalent Residential Units (ERU's)	13,403	15,978	18,462
Average Day Demand (gpd)	2,213,485	2,616,458	3,019,842
Maximum Day Demand (gpd)	5,575,506	6,646,664	7,680,120
Fire Flow Requirement (gpd)	840,000	840,000	840,000
Peak Hour Demand (gpm)[2]	6,278	7,468	8,616
Evaluation of Existing Sources (gpd)			
Available Existing Source [3]			
Rose Hill Supply Station #1 (1,498 gpm)[4]	2,157,120	2,157,120	2,157,120
Rose Hill Supply Station #2 (2,720 gpm)[4]	3,916,800	3,916,800	3,916,800
Rose Hill Supply Station #3 (1,530 gpm)[4]	2,203,200	2,203,200	2,203,200
Total Available Source - 24 hour operation (gpd)	8,277,120	8,277,120	8,277,120
Total Available Source - 20 hour operation (gpd)	6,897,600	6,897,600	6,897,600
Total Available Source - Largest Offline (gpd)	4,360,320	4,360,320	4,360,320
Source Surplus/(Deficiency) (gpd)[5]			
Maximum Day Demand - 24 hour operation	2,701,614	1,630,456	597,000
Maximum Day Demand - 20 hour operation	1,322,094	250,936	(782,520)
Average Day Demand with Largest Source Offline	2,146,835	1,743,862	1,340,478
Fire Storage Replenishment During Max Day Demand[6]	2,629,318	1,558,160	524,704

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include all of the Redmond Rose Hill Service Area (RHSA). ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).
2. Peak hour demand calculated using Equation 3-1 in the 2020 Water System Design Manual, DOH publication 331-123.
3. Sources are assumed to be operating for 24 hours a day.
4. The capacity of the three Rose Hill Supply stations, and the City's share of the total capacity (shared with Kirkland) are documented in Chapter 3 - System Description, Table 3-7.
5. The DOH requirement is that MDD be met by existing sources operating at 24 hours per day. The other comparisons shown are based on DOH recommendations.
6. Fire storage replenishment assumes 72 hour replenishment period. Fire suppression requirement is 3,500 gpm for 4 hours, or 840,000 gallons.

Within the Rose Hill Service Area, water is conveyed amongst multiple pressure zones through PRVs and pump stations. The distribution system hydraulic analysis discussed in Section 10.4 examines the ability of these facilities to move water as needed to meet system demands.

A deficiency identified during a prior planning cycle within this service area that is related to supply is the limited capacity of the North Rose Hill Reservoir and Booster Pump Station to maintain the hydraulic grade line (HGL) in the 545 zone under very low Tolt system heads. During normal operating conditions, the 545 zone is fed directly from the three Rose Hill supply stations, as noted previously. However, during periods of maximum demand upon the Tolt supply system as a whole, the head in the transmission system could drop below 545 feet to the

minimum contract head of 530 feet. The North Rose Hill Booster Pump Station is intended to draw water from the North Rose Hill Reservoir (HGL of 450) and pump into the 545 zone, thus allowing the HGL to be maintained in the 545 zone when the Tolt system head drops below 545. Both the pump station and reservoir are presently undersized to operate under this circumstance while meeting MDD throughout the service area. Redmond and Kirkland are considering a project to upgrade Supply Station No. 3. A potential solution to this issue to be considered at the time of the supply station upgrade, is construction of a dedicated transmission main that would connect Supply Station 3 to the 450 zone, allowing water to flow directly into that zone and the North Rose Hill Reservoir under depressed Tolt head conditions. This, in conjunction with an appropriately sized upgraded North Rose Hill Booster Pump Station, would bolster the ability of the system to support the 545 zone during times of lowered Tolt head.

10.2.3. Bellevue-Overlake-Viewpoint Service Area

Water supply for the Bellevue-Overlake-Viewpoint Service Area is provided by five connections to the TESSL, as listed in Table 10-3. Of these, the NE 40th Street connection is located closest to the area served by Redmond. The remaining four connections are located in areas served by the City of Bellevue. Because these connections are shared with Bellevue, both Redmond and Bellevue demands are included in the source capacity analysis. Bellevue's demands are based on information presented in the Bellevue 2016 Water System Plan and hydraulic model.

In addition, the Bellevue-Overlake-Viewpoint Service Area can receive water from the Rose Hill Service Area through the two connections discussed in the previous section. For the purpose of clarity, no supply from these two connections is considered in this analysis.

As summarized in Table 10-3, the combined capacity of the City's five Bellevue-Overlake-Viewpoint TESSL connections exceeds current and future source capacity requirements for this service area.

Table 10-3. Source Capacity Analysis – Bellevue-Overlake-Viewpoint Service Area

	Year		
Projected ERUs and Demand[1]	**2023**	**2033**	**2043**
Equivalent Residential Units (ERU's)[2]	7,651	9,244	10,787
Average Day Demand - Redmond (gpd)	1,263,622	1,513,859	1,764,508
Maximum Day Demand - Redmond (gpd)	3,182,913	3,845,701	4,487,531
Average Day Demand - Bellevue (gpd)[3]	3,100,012	4,028,093	5,209,046
Maximum Day Demand - Bellevue (gpd)[3]	6,819,935	8,822,650	11,643,622
Fire Flow Requirement (gpd)	840,000	840,000	840,000
Peak Hour Demand - Redmond (gpm)	3,620	4,356	5,069
Evaluation of Existing Sources			
Available Existing Source (gpd)[4]			
NE 8th Street Supply Station (4,200 gpm)	6,048,000	6,048,000	6,048,000
NE 40th Street Supply Station (5,000 gpm)	7,200,000	7,200,000	7,200,000
161st Pump Station (3,500 gpm)	5,040,000	5,040,000	5,040,000
Eastgate Supply Station (4,000 gpm)	5,760,000	5,760,000	5,760,000

SE 28th Supply Station (4,700 gpm)	6,768,000	6,768,000	6,768,000
Total Available Source - 24 hour operation (gpd)	30,816,000	30,816,000	30,816,000
Total Available Source - 20 hour operation (gpd)	25,680,000	25,680,000	25,680,000
Total Available Source - Largest Offline(gpd)	23,616,000	23,616,000	23,616,000
Source Surplus/(Deficiency) (gpd)[5]			
Maximum Day Demand - 24 hour operation	20,813,152	18,147,649	14,684,848
Maximum Day Demand - 20 hour operation	15,677,152	13,011,649	9,548,848
Average Day Demand with Largest Source Offline	19,252,366	18,074,047	16,642,446
Fire Storage Replenishment During Max Day Demand[6]	20,533,152	17,867,649	14,404,848

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include all of the Redmond Well Service Area (WSA). ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).
2. ERUs based on Redmond demands only.
3. Demands for the Bellevue portion of the OSA were taken from the Redmond allocations of the Bellevue zone LH520 demands, described in tables 3-16 through 3-18 of Bellevue's 2016 Water System Plan.
4. Sources are assumed to be operating for 24 hours a day. Source capacities are the total capacities shared between Bellevue and Redmond.
5. The DOH requirement is that MDD be met by existing sources operating at 24 hours per day. The other comparisons shown are based on DOH recommendations.
6. Fire storage replenishment assumes 72 hour replenishment period. Fire suppression requirement is 3,500 gpm for 4 hours, or 840,000 gallons.

Within the Bellevue-Overlake-Viewpoint Service Area, water is conveyed amongst multiple pressure zones through PRVs and the NE 40th Street Pump Station. The distribution system hydraulic analysis discussed in Section 10.4 examines the ability of these facilities to move water as needed to meet system demands.

10.2.4. Novelty Hill Service Area

Water supply for the Novelty Hill Service Area is provided by a connection to the Tolt Tie Line, at the supply station located at Trilogy Parkway NE and NE 125th Street. Water from this supply station is used to meet demands within Novelty Hill and is also wheeled through Redmond's system to a portion of the Sammamish Plateau Water.

The Tolt Tie Line connection serves the 730 pressure zone through a flow- and pressure-reducing control valve, which maintains pressures and supply flow rates appropriate for the pressure zone. In addition, the City's Novelty Hill Pump Station's function is to supply the 730 pressure zone from the Tolt Tie Line should pressures in the Tie Line fall below the level required to supply the 730 pressure zone by gravity. The pump station can operate in three different modes: 1. Pump from the Tolt Tie Line to the Novelty Hill Reservoirs using flow control based on a level indicator. 2. Pump from the Tolt Tie Line to the distribution system using a variable flow to maintain pressure. 3. Pump from the reservoirs to the distribution system using a variable flow to maintain pressure.

As summarized in Table 10-4, the capacity of the Tolt Tie Line supply connection exceeds current source capacity requirements for Novelty Hill. No future demand scenarios are analyzed because Novelty Hill is considered built out and does not anticipate demand increases throughout the 20-year planning horizon.

Table 10-4. Source Capacity Analysis – Novelty Hill Service Area

Projected ERUs and Demand[1]	Year Current
Equivalent Residential Units (ERU's)	5,876
Average Day Demand (gpd)	885,495
Maximum Day Demand (gpd)	2,230,456
Fire Flow Requirement (gpd)	840,000
Peak Hour Demand (gpm)[2]	2,556
Evaluation of Existing Sources (gpd)	
Available Existing Source[3]	
Seattle Tolt Tie Supply Line (7,900 gpm)[4]	11,376,000
Total Available Source - 24 hour operation (gpd)	11,376,000
Total Available Source - 20 hour operation (gpd)	9,480,000
Source Surplus/(Deficiency) (gpd)[5]	
Maximum Day Demand - 24 hour operation	9,145,544
Maximum Day Demand - 20 hour operation	7,249,544
Average Day Demand with Largest Source Offline	N/A
Fire Storage Replenishment During Max Day Demand[6]	8,865,544

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include all of the Novelty Hill Service Area (NHSA). ERUs for the NHSA Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor for Novelty Hill (380 gpd/ERU).
2. Peak hour demand calculated using Equation 3-1 in the 2020 Water System Design Manual, DOH publication 331-123.
3. Sources are assumed to be operating for 24 hours a day.
4. The capacity of the Tolt Tie Supply Line is 7,900 as documented in Chapter 3 - System Description, Table 3-7.
5. The DOH storage capacity requirement for open pressure zones is to meet maximum day demands with existing sources. Average day demand with largest source offline and fire storage replenishment over 72 hours + maximum day demand are DOH recommended source capacity criteria.
6. Fire storage replenishment assumes 72 hour replenishment period. Fire suppression requirement is 3,500 gpm for 4 hours, or 840,000 gallons.

10.3. Storage Capacity Evaluation

The City's storage facilities reliably provide water supply for peak demands in excess of the City's supply capacity and provide supply during fires and other types of emergencies. The storage facilities have been designed to include the storage components required by DOH.

Details regarding DOH requirements and the City's design criteria for the various components are provided in Section 6.4.

The City's existing storage facilities and component volumes are summarized below, followed by an analysis of the ability of these storage volumes to meet current and projected buildout needs.

10.3.1. Existing Storage Facilities

The City's ten storage facilities contain operating, equalizing, fire suppression, standby, and dead storage components. Details regarding key design criteria and assumptions that form the basis for the storage volumes are provided below.

Operating Storage

For most of the City's reservoirs, the top five feet is reserved for operating storage (i.e., that volume that lies between low and high water storage elevations set by City operations staff to control system pumps and flow-control valves). Exceptions are:

- Perrigo Springs and Reservoir Park tanks, for which the top three feet are considered operating storage.
- Rose Hill North Reservoir, for which the top six feet defines the operating storage band.

Equalizing Storage

For reservoirs located within the In-City Service Area, the equalizing storage band was defined during design as the volume of water above the elevation required to provide a static pressure of 40 psi to the highest service connection fed by gravity from the tank, minus the operating storage.

Therefore, the equalizing storage volumes are based in part on the controlling highest service connection elevations, as obtained from the hydraulic model used in the distribution system analysis. Further description regarding certain highest service connection elevations are summarized below:

- *Well Service Area*. In the 238 Zone, there are existing services located above the highest elevation (125 feet). However, these services, which are located northeast of the SE Redmond Reservoir at elevations between 125 and 183 feet, are in fully built-out areas that are planned to be converted to higher pressure zones (300 and 350) in the future.
- *Rose Hill Service Area*. In the 545 Zone, there are seven existing service nodes in the hydraulic model with elevations between the highest elevation (425 feet) and 510 feet. However, these services are located along the north-south transmission line with no feasible means of providing higher pressures via gravity service from the South Rose Hill Reservoir. Similarly, in the 450 Zone, there are three existing service nodes with elevations slightly higher than that noted in the table (340 feet). These services (with elevations of 348 feet) are located near the North Hill Reservoir.
- *Overlake/Viewpoint Service Area*. The NE 40th Street Reservoir does not provide gravity flow to any services. All water from this tank is conveyed into the distribution system through the NE 40th Street Booster Pump Station. As such, there is no highest controlling elevation in this service area. The equalizing storage is therefore

calculated as the entire storage volume less operating storage and that amount reserved for fire flow.

Fire Suppression Storage

As discussed in Section 6.4, the City's largest fire flow requirement is 3,500 gpm for four hours, or 840,000 gallons. This fire suppression volume is provided in each service area and is a part of that volume of the tank(s) in a given service area that provide between 20 and 40 psi to the highest customer elevation.

Standby Storage

Standby storage is the tank volume that can provide above 20 psi to the highest customer elevation, minus the operating, equalizing, and fire suppression storage volumes. In addition, where permanently installed or portable pumping equipment with backup power supplies can be used to boost pressures, storage below 20 psi can be considered standby storage, down to the elevation that the pumping equipment can draw from. With the exception of the Novelty Hill Reservoirs, which have dead storage as described below, the City is able to pump down to the bottom of its reservoirs.

It is also important to note that storage volumes located within the equalizing storage band are available for standby and fire suppression storage, in the event that the entire equalizing band is not needed to meet the calculated equalizing storage requirements.

Dead Storage

Any storage volume that cannot provide a minimum of 20 psi to the highest customer elevation fed by gravity from the tank or through pumps, as described above, is considered dead storage. Only the Novelty Hill Reservoirs have dead storage (a five-foot band at the bottom), since the Novelty Hill Pump Station is set to not operate at suction pressures lower than that provided by five feet of storage volume. This volume is removed from the total available for standby storage in this service area.

10.3.2. Required Storage Volumes

The City's storage facilities were designed to meet the level of service standard that was in place at the time the facility was built. They continue to meet their original design standards. In this analysis, they are also evaluated against current levels of service based on both existing and future water demands. The objective is to identify current and future deficiencies.

Within each of the reservoirs, the operating storage band has been defined and reserved for that purpose. Similarly, required fire suppression storage volumes have also been reserved. Therefore, the existing volumes associated with the remaining storage components (equalizing and standby) have been compared against equalizing and standby storage requirements, which are a function of water demand. Equalizing storage requirements are calculated as 22.75% of maximum day demand. Standby storage is calculated as 400 gallons per ERU (or 800 gallons for Novelty Hill). Additional discussion regarding these methodologies is provided in Section 6.4.

The demand data used in this analysis are the same as those presented in Chapter 4.

The analyses are done amongst pressure zone groupings within the service areas, based on the locations of tanks and the primary zones that they serve, in order to account for the pressure

requirements associated with equalizing storage. Although equalizing and standby storage requirements are calculated and compared with their associated existing storage volumes separately, they are then also shown in a combined fashion, acknowledging that surplus equalizing storage volume is available to aid in meeting standby storage requirements.

Results summaries for each service area are provided below.

In-City Service Area

Each service area within the In-City service area is analyzed separately. Due to the interconnectivity of the In-City service areas, a summary of total In-City service area storage is also included after the service area-specific analyses.

Well Service Area. The analysis for this service area considers two pressure zone groupings: the upper pressure zones served primarily by the Education Hill Reservoirs (470, 565, 390, 350, and 315 zones) is shown in Table 10-5, and the lower pressure zones served primarily/directly by the three 238 zone tanks (238 and 300 zones) is shown in Table 10-6. While this provides an accurate depiction of the equalizing storage analysis, it is noted that due to the connectivity of the pressure zones through PRVs and pump stations, standby storage in all reservoirs is available throughout the service area.

Table 10-5. Upper Well Service Area Storage Analysis

Projected ERUs and Demand[1]	Year		
	2023	**2033**	**2043**
Equivalent Residential Units (ERU's)[2]	8,810	10,425	11,980
Average Day Demand (gpd)	1,454,984	1,707,244	1,959,665
Maximum Day Demand (gpd)	3,664,931	4,336,962	4,983,857
Peak Hour Demand (gpm)	4,155	4,902	5,621
Available Source (gpd)			
NE 172nd Street Supply Station[3]	7,200,000	7,200,000	7,200,000
NE 104th Street Supply Station[3]	7,200,000	7,200,000	7,200,000
Wells #1[4]	1,296,000	1,296,000	1,296,000
Wells #2[4]	720,000	720,000	720,000
Wells #3[4]	691,200	691,200	691,200
Wells #4[4]	576,000	576,000	576,000
Wells #5[4]	1,440,000	1,440,000	1,440,000
Total Available Source (gpd)	19,123,200	19,123,200	19,123,200
Multi-Source Credit (gpd)[5]	11,923,200	11,923,200	11,923,200
Required Storage Calculations			
Operational Storage (gal)[6]	355,424	355,424	355,424
Equalizing Storage (gal)[7]	833,772	986,659	1,133,828
Standby Storage (gal)[8]	3,523,972	4,170,156	4,792,170
Fire Flow Storage (gal)[9]	840,000	840,000	840,000

Required Storage			
During Typical Operation (Greater than 40 or 30 psi at highest meter) (gal)[10]	1,189,196	1,342,083	1,489,252
During a Fire Event (Greater than 20 psi at highest meter) (gal)[11]	2,029,196	2,182,083	2,329,252
During Emergency Operation (gal)[12]	4,713,168	5,512,239	6,281,422
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]			
Education Hill Tank #1 and #2[13]	2,035,750	2,035,750	2,035,750
Total Existing Storage at 40 psi (gal)	2,035,750	2,035,750	2,035,750
Storage Surplus/(Deficiency) at 40 psi (gal)	**846,554**	**693,667**	**546,498**
Available Storage (gal) to Maintain 20 psi [Fire Suppression]			
Education Hill Tank #1 and #2[13]	3,681,868	3,681,868	3,681,868
Total Existing Storage at 20 psi (gal)	3,681,868	3,681,868	3,681,868
Storage Surplus/(Deficiency) at 20 psi (gal)	**1,652,672**	**1,499,785**	**1,352,617**
Available Storage (gal) for Emergency Operation [Standby][14]			
Education Hill Tank #1 and #2	5,000,000	5,000,000	5,000,000
Total Existing Storage (gal)	5,000,000	5,000,000	5,000,000
Storage Surplus/(Deficiency) (gal)	**286,832**	**(512,239)**	**(1,281,422)**

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include demands forecast for pressure zones 470, 565, 390, 350, and 315. ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).
2. Number of ERUs are based on Maximum Day Demand divided by 416 gpd per Max Day ERU.
3. The capacity of the NE 172nd Street and NE 104th Street Supply Stations is each 5,000 gpm as documented in Chapter 3 - System Description.
4. The capacity of Wells #1 - #5 are estimated from Chapter 7 - Source Resource Evaluation. The following flow rates are the maximum permitted pumping rate. Well #1 is 900 gpm, Well #2 is 500 gpm, Well #3 is 480 gpm, Well #4 is 400 gpm, and Well #5 is 1,000 gpm.
5. Multi source credit calculation assumed largest source is off-line, in this case, both the NE 172nd Street Supply Station, or the NE 104th Street Supply Station.
6. Required Operational Storage is based on Storage Tank level when pump turns on. For the Education Hill #1 and #2 and SE Redmond Reservoirs, this is a band or 5 feet or level of 65, 65, and 62.4 feet respectively.
7. Required equalization storage equals the greater of peak hour demand minus total available source or 22.75% of total maximum day demand.
8. Required standby storage is defined for Redmond's Well Service Area as 400 gallons per ERU.
9. Required fire flow storage = 3,500 gpm x 4 hours.
10. Total required storage during typical operations is equal to the total of operational and equalizing storage. This storage must be at an elevation to provide 40 psi to highest service except in the 470 zone where a pressure requirement of 30 psi is used.
11. Total required storage greater than 20 psi is equal to the total of operational, equalizing, and fire flow storage. A minimum pressure of 20 psi when all standby storage volume is depleted is a recommended practice, but not a requirement.
12. Total storage required during an emergency is equal to the total of operational, equalizing, standby, and fire flow storage.

13. The 20 psi and 40 psi requirement is based on the highest service in the 470 Zone. The 470 Zone is used for this analysis as this is the only zone that receives water directly (i.e. not though a pressure reducing station) by gravity from the Education Hill #1 and #2 Reservoirs. The highest elevation in the 470 Zone is 372.3 feet.

14. Total available storage to meet operational, equalizing, and the greater of fire suppression or standby (fire suppression storage can be nested in standby storage). Total available storage is the entire reservoir capacity because the reservoirs can be pumped.

Table 10-6. Lower Well Service Area Storage Analysis

Projected ERUs and Demand[1]	Year		
	2023	**2033**	**2043**
Equivalent Residential Units (ERU's)[2]	13,837	16,374	18,817
Average Day Demand (gpd)	2,285,225	2,681,431	3,077,888
Maximum Day Demand (gpd)	5,756,211	6,811,716	7,827,742
Peak Hour Demand (gpm)	6,479	7,652	8,780
Available Source (gpd)			
NE 172nd Street Supply Station[3]	7,200,000	7,200,000	7,200,000
NE 104th Street Supply Station[3]	7,200,000	7,200,000	7,200,000
Wells #1[4]	1,296,000	1,296,000	1,296,000
Wells #2[4]	720,000	720,000	720,000
Wells #3[4]	691,200	691,200	691,200
Wells #4[4]	576,000	576,000	576,000
Wells #5[4]	1,440,000	1,440,000	1,440,000
Total Available Source (gpd)	19,123,200	19,123,200	19,123,200
Multi-Source Credit (gpd)[5]	11,923,200	11,923,200	11,923,200
Required Storage Calculations			
Operational Storage (gal)[6]	836,991	836,991	836,991
Equalizing Storage (gal)[7]	1,309,538	1,549,665	1,780,811
Standby Storage (gal)[8]	5,534,818	6,549,727	7,526,675
Fire Flow Storage (gal)[9]	840,000	840,000	840,000
Required Storage			
During Typical Operation (Greater than 40 or 30 psi at highest meter) (gal)[10]	2,146,529	2,386,657	2,617,803
During a Fire Event (Greater than 20 psi at highest meter) (gal)[11]	2,986,529	3,226,657	3,457,803
During Emergency Operation (gal)[12]	7,681,348	8,936,384	10,144,478
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]			
Reservoir Park[13]	3,110,100	3,110,100	3,110,100
Perrigo Springs[13]	345,567	345,567	345,567
SE Redmond [13]	1,384,318	1,384,318	1,384,318
Total Existing Storage at 40 psi (gal)	4,839,984	4,839,984	4,839,984
Storage Surplus/(Deficiency) at 40 psi (gal)	**2,693,455**	**2,453,327**	**2,222,181**

Available Storage (gal) to Maintain 20 psi [Fire Suppression]			
Reservoir Park[13]	4,200,000	4,200,000	4,200,000
Perrigo Springs[13]	500,000	500,000	500,000
SE Redmond [13]	4,463,022	4,463,022	4,463,022
Total Existing Storage at 20 psi (gal)	9,163,022	9,163,022	9,163,022
Storage Surplus/(Deficiency) at 20 psi (gal)	**6,176,493**	**5,936,365**	**5,705,219**
Available Storage (gal) for Emergency Operation [Standby][14]			
Reservoir Park	4,200,000	4,200,000	4,200,000
Perrigo Springs	500,000	500,000	500,000
SE Redmond	4,500,000	4,500,000	4,500,000
Total Existing Storage (gal)	9,200,000	9,200,000	9,200,000
Storage Surplus/(Deficiency) (gal)	**1,518,652**	**263,616**	**(944,478)**

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include demands forecasted for pressure zones 238 and 300. ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).
2. Number of ERUs are based on Maximum Day Demand divided by 416 gpd per Max Day ERU.
3. The capacity of the NE 172nd Street and NE 104th Street Supply Stations is each 5,000 gpm as documeted in Chapter 3 - System Description.
4. The capacity of Wells #1 - #5 are estimated from Chapter 7 - Source Resource Evaluation. The following flow rates are the maximum permitted pumping rate. Well #1 is 900 gpm, Well #2 is 500 gpm, Well #3 is 480 gpm, Well #4 is 400 gpm, and Well #5 is 1,000 gpm.
5. Multi source credit calculation assumed largest source is off-line, in this case, both the NE 172nd Street Supply Station, or the NE 104th Street Supply Station.
6. Required Operational Storage is based on Storage Tank level when pump turns on. For the Reservoir Park and Perrigo Spring Reservoirs, this is a band or 3 feet or level of 25 and 27 feet respectively. For the Education Hill #1 and #2 and SE Redmond Reservoirs, this is a band or 5 feet or level of 65, 65, and 62.4 feet respectively.
7. Required equalization storage equals the greater of peak hour demand minus total available source or 22.75% of total maximum day demand.
8. Required standby storage is defined for Redmond's Well Service Area as 400 gallons per ERU.
9. Required fire flow storage = 3,500 gpm x 4 hours.
10. Total required storage during typical operations is equal to the total of operational and equalizing storage. This storage must be at an elevation to provide 40 psi to highest service except in the 470 zone where a pressure requirement of 30 psi is used.
11. Total required storage greater than 20 psi is equal to the total of operational, equalizing, and fire flow storage. A minimum pressure of 20 psi when all standby storage volume is depleted is a recommended practice, but not a requirement.
12. Total storage required during an emergency is equal to the total of operational, equalizing, standby, and fire flow storage.
13. The 20 psi and 40 psi requirement is based on the highest service in the 238 Zone. The 238 Zone is used for this analysis as this is the only zone that receives water directly (i.e. not though a pressure reducing station) by gravity from the Perrigo Springs, SE Redmond, and Reservoir Park Reservoirs. The highest elevation in the 238 Zone is 183 feet, however, areas of low pressure in this zone will be addressed in distribution system analysis. Excluded from this pressure requirement are to the northeast of the SE Redmond Reservoir, four nodes in distribution system, three nodes by PRV-47, and many nodes by the SE Redmond Reservoir in the 238 zone which have an elevation greater than 125 feet.
14. Total available storage to meet operational, equalizing, and the greater of fire suppression or standby (fire suppression storage can be nested in standby storage). Total available storage is the entire reservoir capacity because the reservoirs can be pumped.

There are currently storage surpluses for the 40 and 20 psi requirements in both the upper and lower Well Service Area pressure zone groupings, which will remain in surplus through the end of the planning period. However, the analysis indicates that standby storage becomes insufficient in the upper zone at the 10-year planning horizon, and that standby storage becomes insufficient for both zone groupings in the 20-year planning horizon. However, water from storage can be moved between the upper and lower zone groupings through booster pumps and PRVs, providing additional redundancy to meet supply requirements during an emergency.

Rose Hill Service Area. The analysis for this service area considers two pressure zone groupings: the upper pressure zones served most directly by the South Rose Hill Reservoir (545, 650, 425, and 335 zones), and the lower pressure zones served primarily/directly by the North Rose Hill Reservoir (450, 395, and 285). Table 10-7 and Table 10-8 display the storage analyses for the upper and lower Rose Hill Service Area, respectively.

Table 10-7. Upper Rose Hill Storage Capacity Analysis

Projected ERUs and Demand[1]	Year		
	2023	**2033**	**2043**
Equivalent Residential Units (ERU's)[2]	9,376	11,178	12,915
Average Day Demand (gpd)	1,548,500	1,830,410	2,112,608
Maximum Day Demand (gpd)	3,900,488	4,649,844	5,372,825
Peak Hour Demand (gpm)	4,392	5,225	6,028
Available Source (gpd)			
Rose Hill Supply Station #1 (1,498 gpm)[4]	2,157,120	2,157,120	2,157,120
Rose Hill Supply Station #2 (2,720 gpm)[4]	3,916,800	3,916,800	3,916,800
Rose Hill Supply Station #3 (1,530 gpm)[4]	2,203,200	2,203,200	2,203,200
Total Available Source (gpd)	8,277,120	8,277,120	8,277,120
Multi-Source Credit (gpd)[4]	4,360,320	4,360,320	4,360,320
Required Storage Calculations			
Operational Storage (gal)[5]	240,143	240,143	240,143
Equalizing Storage (gal)[6]	887,361	1,057,840	1,222,318
Standby Storage (gal)[7]	3,750,469	4,471,004	5,166,178
Fire Flow Storage (gal)[8]	216,888	216,888	216,888
Required Storage			
During Typical Operation (Greater than 40 psi at highest meter) (gal)[9]	1,127,504	1,297,982	1,462,460
During a Fire Event (Greater than 20 psi at highest meter) (gal)[10]	1,344,392	1,514,870	1,679,348
During Emergency Operation (gal)[11]	4,877,973	5,768,986	6,628,638
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]			
South Rose Hill Reservoir[12,13]	1,321,221	1,321,221	1,321,221

Total Existing Storage at 40 psi (gal)	1,321,221	1,321,221	1,321,221
Storage Surplus/(Deficiency) at 40 psi (gal)	**193,718**	**23,239**	**(141,239)**
Available Storage (gal) to Maintain 20 psi [Fire Suppression]			
South Rose Hill Reservoir[12,13]	2,408,000	2,408,000	2,408,000
Total Existing Storage at 20 psi (gal)	2,408,000	2,408,000	2,408,000
Storage Surplus/(Deficiency) at 20 psi (gal)	**1,063,608**	**893,130**	**728,652**
Available Storage (gal) for Emergency Operation [Standby][14]			
South Rose Hill Reservoir[11]	2,408,000	2,408,000	2,408,000
Total Existing Storage (gal)	2,408,000	2,408,000	2,408,000
Storage Surplus/(Deficiency) (gal)	**(2,469,973)**	**(3,360,986)**	**(4,220,638)**

Notes:

1. Projected demands are generated by reviewing available land, zone by parcel data, and meter use. The demands include demands forecast for pressure zones 545, 650, 425, and 335 of the RHSA.
2. Number of ERUs are based on Maximum Day Demand divided by 416 gpd per Max Day ERU.
3. The capacity of shared Rose Hill Supply Station #1, #2, and #3 is 42.8%, 34%, and 34% respectively, as documented in Chapter 2 - System Description. Redmond's portions of these supply stations are 1,498 gpm, 2,720 gpm, and 1,530 gpm respectively.
4. Multi source credit assumes the largest interconnection with the TESSL is out of service.
5. Required Operational Storage is based on Storage Tank level when pump turns on. For South Rose Hill Reservoir this is a band of 5 feet or a level of 45 feet. The reservoir is shared with Kirkland and 21.5% of the South RS Reservoir is available to Redmond.
6. Required equalization storage equals 22.75% of total maximum day demand.
7. Required standby storage is defined for Redmond's Rose Hill Service Area as 400 gallons per ERU.
8. Required fire flow storage = 3,500 gpm x 4 hours. This requirement is shared with Kirkland with Redmond responsible for 25.82% of the fire storage and Kirkland responsible for 74.18% of the total fire storage requirement. Redmond's percentage of fire storage requirement is the weighted average of Redmond's percentage of the North and South Rose Hill Reservoir
9. Total required storage greater than 40 psi is equal to the total of operational and equalizing storage.
10. Total required storage greater than 20 psi is equal to the total of operational, equalizing, and fire flow storage. A minimum pressure of 20 psi when all standby storage volume is depleted is a recommended practice, but not a requirement.
11. Total storage required during an emergency is equal to the total of operational, equalizing, standby, and fire flow storage.
12. The volume of the South Rose Hill Reservoir is 11.2 Million Gallons. This facility is shared with Kirkland and 21.5% or 2.4 Million Gallons is available to Redmond.
13. The 20 psi and 40 psi requirement is based on the highest service in the 545 Zone. The 545 Zone is used for this analysis as this is the only zone that receives water directly (i.e. not though a pressure reducing station) by gravity from the South Rose Hill Reservoir. The highest service elevation in the Redmond Rose Hill and Kirkland 545 Zone is 510 feet, however, there are only seven service nodes with elevations greater than 425 feet. They are around the along the north-south transmission line, one southeast of South RH Reservoir, and supply PRV, therefore, an elevation of 425.3 feet is used to calculate the pressure requirements.
14. Total available storage to meet operational, equalizing, and the greater of fire suppression or standby (fire suppression storage can be nested in standby storage). Total available storage is the entire reservoir capacity because the reservoirs can be pumped.

Table 10-8. Lower Rose Hill Storage Analysis

Projected ERUs and Demand[1]	Year 2023	2033	2043
Equivalent Residential Units (ERU's)[2]	4,026	4,800	5,546
Average Day Demand (gpd)	664,985	786,048	907,234
Maximum Day Demand (gpd)	1,675,018	1,996,819	2,307,295
Peak Hour Demand (gpm)	1,886	2,244	2,589
Available Source (gpd)			
Rose Hill Supply Station #1 (1,498 gpm)[4]	2,157,120	2,157,120	2,157,120
Rose Hill Supply Station #2 (2,720 gpm)[4]	3,916,800	3,916,800	3,916,800
Rose Hill Supply Station #3 (1,530 gpm)[4]	2,203,200	2,203,200	2,203,200
Total Available Source (gpd)	8,277,120	8,277,120	8,277,120
Multi-Source Credit (gpd)[4]	4,360,320	4,360,320	4,360,320
Required Storage Calculations			
Operational Storage (gal)[5]	244,100	244,100	244,100
Equalizing Storage (gal)[6]	381,066	454,276	524,910
Standby Storage (gal)[7]	1,610,594	1,920,019	2,218,553
Fire Flow Storage (gal)[8]	216,888	216,888	216,888
Required Storage			
During Typical Operation (Greater than 40 psi at highest meter) (gal)[9]	625,166	698,376	769,009
During a Fire Event (Greater than 20 psi at highest meter) (gal)[10]	842,054	915,264	985,897
During Emergency Operation (gal)[11]	2,235,760	2,618,395	2,987,562
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]			
North Rose Hill Reservoir[12,13]	718,933	718,933	718,933
Total Existing Storage at 40 psi (gal)	718,933	718,933	718,933
Storage Surplus/(Deficiency) at 40 psi (gal)	**93,767**	**20,557**	**(50,076)**
Available Storage (gal) to Maintain 20 psi [Fire Suppression]			
North Rose Hill Reservoir[12,13]	2,588,311	2,588,311	2,588,311
Total Existing Storage at 20 psi (gal)	2,588,311	2,588,311	2,588,311
Storage Surplus/(Deficiency) at 20 psi (gal)	**1,746,257**	**1,673,047**	**1,602,414**
Available Storage (gal) for Emergency Operation [Standby][14]			
North Rose Hill Reservoir[12]	4,175,600	4,175,600	4,175,600
Total Existing Storage (gal)	4,175,600	4,175,600	4,175,600
Storage Surplus/(Deficiency) (gal)	**1,939,840**	**1,557,205**	**1,188,038**

Notes:

1. Projected demands are generated by reviewing available land, zone by parcel data, and meter use. The demands include demands forecast for pressure zones 450, 395, and 285 of the RHSA.

2. Number of ERUs are based on Maximum Day Demand divided by 416 gpd per Max Day ERU.
3. The capacity of shared Rose Hill Supply Station #1, #2, and #3 is 42.8%, 34%, and 34% respectively, as documeted in Chapter 2 - System Description. Redmond's portions of these supply stations are 1,498 gpm, 2,720 gpm, and 1,530 gpm respectively.
4. Multi source credit assumes the largest interconnection with the TESSL is out of service.
5. Required Operational Storage is based on Storage Tank level when pump turns on. The North Rose Hill Reservoir has an operational band of 6 feet or a level of 97 feet. The reservoir is shared with Kirkland; 29.2% of the North RH Reservoir is available to Redmond.
6. Required equalization storage equals 22.75% of total maximum day demand.
7. Required standby storage is defined for Redmond's Rose Hill Service Area as 400 gallons per ERU.
8. Required fire flow storage = 3,500 gpm x 4 hours. This requirement is shared with Kirkland with Redmond responsible for 25.82% of the fire storage and Kirkland responsible for 74.18% of the total fire storage requirement. Redmond's percentage of fire storage requirement is the weighted average of Redmond's percentage of the North and South Rose Hill Reservoir
9. Total required storage greater than 40 psi is equal to the total of operational and equalizing storage.
10. Total required storage greater than 20 psi is equal to the total of operational, equalizing, and fire flow storage. A minimum pressure of 20 psi when all standby storage volume is depleted is an accepted practice, but not a requirement.
11. Total storage required during an emergency is equal to the total of operational, equalizing, standby, and fire flow storage.
12. The volume of the South Rose Hill Reservoir is 14.3 Million Gallons. This facility is shared with Kirkland and 29.2% or 4.175 Million Gallons is available to Redmond.
13. The 20 psi and 40 psi requirement is based on the highest service in the 450 Zone. The 450 Zone is used for this analysis as this is the only zone that receives water directly (i.e. not though a pressure reducing station) by gravity from the North Rose Hill Reservoir. The highest service elevation in the Remond Rose Hill and Kirkland 450 Zone is 348 feet, however, there are only three service nodes with elevations greater than 340 feet. They are around the North Rose Hill Reservoir, therefore, an elevation of 340 feet is used to calculate the pressure requirements.
14. Total available storage to meet operational, equalizing, and the greater of fire suppression or standby (fire suppression storage can be nested in standby storage). Total available storage is the entire reservoir capacity because the reservoirs can be pumped.

Storage is sufficient for 40 and 20 psi requirements through the 10-year planning horizon. At the 20-year horizon, storage is not sufficient to meet both operational and equalizing storage requirements (the 40 psi requirement) in both the upper and lower zones by 0.14 million gallons and 0.05 million gallons, respectively. Storage is insufficient to cover standby storage requirements in the upper pressure zone grouping during all planning horizons. Storage is sufficient to cover standby storage requirements in the lower pressure zone grouping throughout the planning horizon. Water from storage can be moved between the upper and lower zone groupings through booster pumps and PRVs, providing additional redundancy to meet supply requirements during an emergency.

Bellevue/Overlake/Viewpoint Service Area. The analysis for this service area is not broken out by pressure zones, because there is only one reservoir, and it does not provide gravity flow to any services. Because of the interconnectivity of the Redmond and Bellevue systems in this service area, the two cities essentially share all of their storage. However, the two systems have different level-of-service criteria for standby storage, with Redmond's standard requiring a greater volume of storage. For the purpose of this analysis, it was assumed that Redmond owns 44% of the tank, or approximately 2.09 million gallons of storage. Table 10-9 displays the storage capacity analysis for the Overlake Service Area.

Table 10-9. Overlake Storage Analysis

Projected ERUs and Demand[1]	Year 2023	2033	2043
Equivalent Residential Units (ERU's)[2]	7,651	9,244	10,787
Average Day Demand (gpd)	1,263,622	1,513,859	1,764,508
Maximum Day Demand (gpd)	3,182,913	3,845,701	4,487,531
Peak Hour Demand (gpm)	3,620	4,356	5,069
Available Source (gpd)[3]			
NE 40th Pump Station (5,000 gpm)	8,640,000	8,640,000	8,640,000
Total Available Source (gpd)[4]	8,640,000	8,640,000	8,640,000
Multi-Source Credit (gpd)	8,640,000	8,640,000	8,640,000
Required Storage Calculations			
Operational Storage (gal)[5]	373,518	373,518	373,518
Equalizing Storage (gal)[6]	724,113	724,113	1,020,913
Standby Storage (gal)[7]	3,060,494	3,697,789	4,314,933
Fire Flow Storage (gal)[8]	369,600	369,600	369,600
Required Storage			
During Typical Operation (Greater than 40 psi at highest meter) (gal)[9]	1,097,631	1,097,631	1,394,432
During a Fire Event (Greater than 20 psi at highest meter) (gal)[10]	1,467,231	1,467,231	1,764,032
During Emergency Operation (gal)[11]	4,158,125	4,795,420	5,709,365
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]			
NE 40th Street Reservoir[12]	2,086,371	2,086,371	2,086,371
Total Existing Storage during Typical Operation (gal)	2,086,371	2,086,371	2,086,371
Storage Surplus/(Deficiency) during Typical Operation (gal)	**988,739**	**988,739**	**691,939**
Available Storage (gal) to Maintain 20 psi [Fire Suppression][11]			
NE 40th Street Reservoir[12]	2,086,371	2,086,371	2,086,371
Total Existing Storage during a Fire Event (gal)	2,086,371	2,086,371	2,086,371
Storage Surplus/(Deficiency) during Fire Event (gal)	**619,139**	**619,139**	**322,339**
Available Storage (gal) for Emergency Operation [Standby][11]			
NE 40th Street Reservoir[12]	2,086,371	2,086,371	2,086,371
Total Existing Storage during Emergency Operation (gal)	2,086,371	2,086,371	2,086,371
Storage Surplus/(Deficiency) during Emergency Operation (gal)	**(2,071,754)**	**(2,709,050)**	**(3,622,994)**

Notes:

1. Projected demands are generated by multiplying the forecasted demands described in Chapter 4 by service area allocations developed using billing data. The demands include all of the Redmond Overlake Service Area (OSA). ERUs for the City Service Area calculated as Maximum Day Demand / Maximum Day ERU water use factor (416 gpd/ERU).

2. Number of ERUs are based on Maximum Day Demand divided by 416 gpd per Max Day ERU.
3. The reservoir is only accessible through the NE 40th Pump Station. Source is assumed to be operating for 24 hours a day.
4. No multi source credit is taken for the Bellevue-Overlake-Viewpoint Service Area.
5. Required Operational Storage is based on Storage Tank level when pump turns on, for the NE 40th Street Reservoir this is a level of 31 feet or the top 5 feet of the reservoir. These reservoirs are shared with Bellevue and 44% is available to Redmond. This analysis only requires the percentage of operational storage (44%) that is Redmond's responsibility.
6. Required equalization storage equals 22.75% of total maximum day demand.
7. Required standby storage is defined for Redmond's BOV Service Area as 400 gallons per ERU.
8. Required fire flow storage = 3,500 gpm x 4 hours. This requirement is shared with Bellevue with Redmond responsible for 44% of the fire storage and Bellevue responsible for 56% of the total fire storage requirement. Redmond's percentage of fire storage requirement is Redmond's portion of the NE 40th Street Reservoir
9. Total required storage during typical operation is equal to the total of operational and equalizing storage.
10. Total required storage during emergency operation is equal to the total of operational, equalizing, and fire flow storage.
11. The 20 psi and 40 psi pressure requirements are not applicable in this analysis as the NE 40th Street Reservoir does not serve any zones via gravity. The bottom 8 feet or 1.4 MG are considered dead storage that the NE 40th Street Pump Station can not be utilized.
12. The total volume of the NE 40th Street Reservoir is 6 Million Gallons. As stated in footnote 11 the dead storage is 1.36 MG. The total usable volume is 4.64 MG. This facility is shared with Bellevue and Redmond owns 44% of the tank or 2.09 million gallons is available to Redmond.

There are currently storage surpluses for the 40 and 20 psi requirements throughout the entire planning period. Standby storage is insufficient by 2.07 million gallons with present demands, which grows to a deficiency of approximately 3.6 million gallons by 2043. Redmond and Bellevue will consider additional storage in their combined service area. It would be impractical for Redmond alone to construct additional storage to meet its higher level of service standard as this water would also be used by Bellevue in the event the utilities need to sustain operations on standby storage.

Combined In-City Storage. The interconnectivity of each In-City service area allows for transfer of water between zones during an emergency, thereby supplementing standby storage in those zone groupings that are currently deficient. Table 10-10 displays a summary of standby storage requirements and available storage for the entire In-City service area.

Table 10-10. In-City Service Area Standby Storage Analysis

Service Area	Standby Storage Requirement[1]		
	2023	2033	2043
Well[2]	12,394,516	14,448,623	16,425,900
Rose Hill[2]	7,113,733	8,387,381	9,616,200
Overlake	4,158,125	4,795,420	5,709,365
Total Available Storage[3]	*22,899,171*	*22,899,171*	*22,899,171*
Standby Storage Surplus/(Deficiency)[4]	(767,202)	(4,732,253)	(8,852,294)

Notes:
[1] Standby storage requirement, for the sake of this evaluation, is the sum of operational, equalizing, and standby storage, per the storage design requirements.
[2] Standby storage requirements are the sum of the requirements of the two sub-zones in the identified service areas.
[3] Total available storage in the entire In-City Service Area. All storage is accessible through pumping out of the reservoirs.
[4] Total available storage minus the sum of standby storage requirements of the three In-City service areas.

There is a current deficiency of standby storage in the In-City Service Area of approximately 0.77 million gallons, which grows to a deficiency of approximately 8.9 million gallons in 2043. This deficiency is based on the City's standby storage standard of 400 gpd/ERU rather than DOH's planning standard of 200 gpd/ERU. Using the DOH standard, no deficiencies are forecast in the 20-year planning horizon. However, the City will continue to plan for future facilities using its own, stricter standard. The City is considering additional storage to meet the standby storage needs identified in these analyses.

Novelty Hill Service Area

Table 10-11 displays the storage capacity analysis for the Novelty Hill Service Area. The service area is considered built-out. Therefore, only current demands are analyzed for storage sufficiency. The existing storage facilities in Novelty Hill provide sufficient storage volumes to meet current requirements.

Table 10-11. Novelty Hill Storage Analysis

	Year
Projected ERUs and Demand[1]	**Current**
Equivalent Residential Units (ERU's)[2]	5,876
Average Day Demand (gpd)	885,495
Maximum Day Demand (gpd)	2,230,456
Peak Hour Demand (gpm)	2,556
Available, Existing Source (gpd)	
Seattle Tolt Tie Supply Line[3]	11,376,000
Total Available Source (gpd)	11,376,000
Multi-Source Credit (gpd)[4]	0
Required Storage Calculations	
Operational Storage (gal)[5]	321,615
Equalizing Storage (gal)[6]	507,429
Standby Storage (gal)[7]	4,700,645
Fire Flow Storage (gal)[8]	840,000
Required Storage	
During Typical Operation (Greater than 40 psi at highest meter) (gal)[9]	829,044
During a Fire Event (Greater than 20 psi at highest meter) (gal)[10]	1,669,044
During Emergency Operation (gal)[11]	5,529,689
Available Storage (gal) to Maintain 40 psi [Operational and Equalizing]	
Novelty Hill Tank #1	767,705
Novelty Hill Tank #2	1,219,296
Total Existing Storage at 40 psi (gal)	1,987,001
Storage Surplus/(Deficiency) at 40 psi (gal)	**1,157,958**

Available Storage (gal) to Maintain 20 psi [Fire Suppression]	
Novelty Hill Tank #1	1,912,094
Novelty Hill Tank #2	3,036,856
Total Existing Storage at 20 psi (gal)	4,948,950
Storage Surplus/(Deficiency) at 20 psi (gal)	**3,279,907**
Available Storage (gal) for Emergency Operation [Standby](12)	
Novelty Hill Tank #1	3,057,518
Novelty Hill Tank #2	4,856,058
Total Existing Storage During Emergency Event (gal)	7,913,577
Storage Surplus/(Deficiency) During Emergency Event (gal)	**2,383,888**

Notes:

1. Projected demands are generated by reviewing available land, zone by parcel data, and meter use. The demands include demands forecast for pressure zones 450, 395, and 285 of the RHSA.
2. Number of ERUs are based on Average Day Demand divided by 169 gpd per ERU.
3. The capacity of the Novelty Hill Supply Stations is 7,900 gpm as documeted in Chapter 3 - System Description.
4. Multi source credit is not available as there is only one transmission system (i.e. one source), the Seattle Tolt Tie Line, serving the Novelty Hill Service Area.
5. Required Operational Storage is based on Storage Tank level when pump turns on, for the Novelty Hill Reservoirs this is a level of 132 feet or the top 5 feet of the reservoir.
6. Required equalization storage equals 22.75% of total maximum day demand.
7. Required standby storage is defined for Redmond's Novelty Hill Service Area as 800 gallons per ERU.
8. Required fire flow storage = 3,500 gpm x 4 hours.
9. Total required storage greater than 40 psi is equal to the total of operational and equalizing storage.
10. Total required storage greater than 20 psi is equal to the total of operational, equalizing, and fire flow storage.
11. Total storage required during an emergency is equal to the total of operational, equalizing, and the greater of standby or fire suppression storage.
12. Total available storage to meet operational, equalizing, and the greater of standby storage or fire suppression storage during an emergency event. Novelty Hill Pump Station has an emergency event operating mode which allows the Novelty Hill Reservoirs to be isolated from the 730 zone and emptied via the pump station into the 730 zone without causing low pressure issues. Total available storage is equal to the volume of the storage tank with a 5 feet band of dead storage removed.

10.4. Distribution System Evaluation

The City's distribution system was analyzed with hydraulic models to identify areas unable to meet the following levels of service, as defined in more detail in Chapter 5:

1. Maintain pressures of 40 psi or greater at each service connection during periods of maximum use.
2. During fire flow events, assuming maximum instantaneous demands:
    a. Maintain minimum pressures of 20 psi at all locations
    b. Maximum velocity of 10 feet per second (fps) in distribution system network pipes

10.4.1. Hydraulic Analysis Methodology

The City's distribution system is represented in three separate hydraulic models: the Rose Hill – Well Service Area (RH-WSA), the Bellevue-Overlake-Viewpoint Service Area (BOV), and the Novelty Hill Service Area (NVH). The models are constructed in the modeling software platform WaterGEMS by Bentley.

The models were calibrated in 2011 using Supervisory Control and Data Acquisition (SCADA) data and fire flow tests conducted at hydrants. During this steady-state calibration minor loss components were added to pressure reducing valves (PRV) and settings were adjusted for control valves and pump curves to replicate system boundary conditions and headloss. In 2018, the BOV model was updated with piping added since 2011, and was calibrated using data from five hydrant flow tests. In 2019, the RH-WSA model was updated with piping added since 2011, and was calibrated using data from 12 hydrant flow tests. Additional analyses conducted using the model between 2019 and 2021 involved minor additional updates to the model to reflect small physical piping changes.

As part of the WSP update effort in early 2023, the calibrated model demands were updated for each planning scenario and deficiencies were identified based on criteria stated above. No other calibration was conducted due to the recent calibration efforts as noted above.

System Components

Three existing hydraulic models were used in this analysis: one for the Well Service and Rose Hill Service Areas, one for the Bellevue/Overlake/Viewpoint Service Area, and one for the Novelty Hill Service Area. Each model contained the following primary system components:

- Pipes
- Junctions
- Pressure reducing valves
- Reservoirs
- Pump stations
- Supply Station and Well source information

Hazen Williams C values were assigned to each pipe, to characterize the friction loss attributable to different pipe materials. These values are summarized in Table 10-12.

Table 10-12. Hazen Williams C Values for Pipe Materials

Material	C Value
Asbestos Cement	120
Cast iron	100
Ductile iron	130
PVC	130
Steel	100
Unknown	100

As part of this Water System Plan update, Redmond's existing WaterGEMS models were updated to include pipes installed in the system since the last modeling analysis (e.g., portions of the Novelty Hill infrastructure, adding 8-inch pipe along 183rd Ave), update closed/abandoned

pipes in the system (abandoned 12-inch pipe near Microsoft complex and updating pipe sizes) and update pressure reducing station locations based on input from City staff. Updated GIS information were used as a basis for defining the new facilities placed into the model.

Water Demand Allocation

The demand data used in the hydraulic analyses were developed through analysis of parcel-level data for existing and future modeling scenarios. This was done in order to support spatial distribution of demands across the water system's various service areas and pressure zones.

Existing (2023) Demands

Meter consumption data for 2019 were used to allocate demands in the hydraulic models. These spatially-allocated demands were then adjusted based on the demand forecasts mentioned in Chapter 4 to arrive at existing demands that reflect demands for year 2023. The existing water demand for Redmond City service area in the three models is shown in Table 10-13.

Table 10-13. 2023 Demands from Demand Allocation

Planning Year	RH-WSA Average Day Demand (gpm)	BOV Average Day Demand (gpm)	NVH Average Day Demand (gpm)
2019	3,260	1,020	530
Existing (2023)	3,810	1,190	520

For the Novelty Hill Service Area (NVH), the same methodology was followed, and demands were allocated throughout the entire service area. The NVH system provides water to a golf course that can draw relatively large amounts of water from the system.

For the Bellevue-Overlake-Viewpoint Service Area (BOV), the City's demand database includes nodes only in the Redmond portion of the service area, whereas the BOV model itself includes other areas served by the City of Bellevue. The demands outside the Redmond portion of the service area were not adjusted for planning year 2019. Demands for areas served by City of Bellevue for all future planning scenarios were interpolated using demand forecasts from City of Bellevue's most recent master plan update. The updated total existing (2023) demand for BOV, including Bellevue demands, was 3,336 gpm.

For the Rose Hill – Well Service Area (RH-WSA), the City's demand database includes nodes only in the Redmond portion of the service area, whereas the RH-WSA model itself includes other areas served by the City of Kirkland.

The updated demand assignment for the Existing 2023 demand alternative for the RH-WSA model was performed separately for three geographical regions:

1. West of I-405. The RH-WSA model does not need to include the Kirkland infrastructure west of I-405. In the Kirkland model, junctions west of I-405 have an ADD of 2,095 gpm. This demand is met by pipes that cross I-405 at 60th Street, 85th Street, and 116th Street. The ADD was applied in three equal demands of 698 gpm at the model nodes on the west side of these three crossings. These demands were assumed to be the same for planning year 2019 and were increased with the same factor as used for the Redmond City area for the existing, 10-year and 20-year modeling scenarios.

2. East of I-405 and west of Redmond service area. This area is served by the City of Kirkland, but the infrastructure affects the supply to the City of Redmond. Therefore, this area was included in the RH-WSA model. In the Kirkland model, the junctions in this area had an ADD of 612 gpm. These demands were assumed to be the same for planning year 2019 and were increased with the same factor as used for the Redmond City area for the existing, 10-year and 20-year modeling scenarios.
3. Inside Redmond service area. The RH-WSA junctions inside the Redmond service area were assigned demands as part of the demand allocation task. These junction demands were updated in the WaterGEMS model for the Existing 2023 ADD demand alternative. The ADD for these nodes was 3,810 gpm.

The total ADD assigned to the RH-WSA model for Existing 2023 conditions, including Kirkland demands, was 7,006 gpm.

Future Modeling Scenario Demands

Existing system demands were increased to 10-year (2033) and 20-year (2043) scenarios based on the demands forecasted. The total demands for 10-year and 20-year future modeling scenarios for the Redmond City Service area nodes in the three models are shown in Table 10-14.

Table 10-14. Future Demands from Demand Allocation

Model		RH-WSA			BOV			NVH
Service Area		Redmond	Kirkland	Total	Redmond	Bellevue	Total	Redmond
Planning Year	Scenario	ADD (gpm)	ADD (gpm)	ADD (gpm)	ADD (gpm)	ADD (gpm)	ADD (gpm)	ADD (gpm)
10 – year 2033	ADD	4,490	3,770	8,260	1,410	2,790	4,200	520
20 – year 2043	ADD	5,180	4,340	9,520	1,620	3,610	5,230	520

For RH-WSA, the demand database includes nodes only in the Redmond portion of the service area. The increase in demands in the Kirkland area for the future modeling scenarios was assumed to be consistent with Redmond City Area.

For BOV, the City's demand database includes nodes only in the Redmond portion of the service area. Bellevue's demands (i.e., those outside the Redmond portion of the service area) were adjusted based on demand forecasts given in the City's most recent master plan. The updated total demand for 20-year planning scenario, including Bellevue demands, was 14,928 gpm.

For NVH, demands were allocated throughout the entire service area. NVH service area is considered built out and the demands allocated for each planning scenario are representative of that.

Maximum Day and Peak Hour Demands

Modeling scenarios were created to evaluate conditions during MDD and PHD conditions. Demand scenarios for these conditions were created in the hydraulic model by using peaking factors to increase the values of ADD that had been assigned to each node using the procedure described in the above sections for existing and future modeling scenarios. The peaking factor

is 2.3 for ADD to MDD for all the models. The peak hour demand factors were calculated using equation 3-1 from the 2020 Water System Design Manual. The equation calculates a peaking factor based on the number of ERUs in each service area. The peak hour demand factors for each service area are calculated as given below:

Table 10-15. Peak Hour Demand* Factors per Planning Year

Planning Year	RH-WSA	BOV	NVH
2019	4.08	4.12	4.55
2023	4.08	4.12	4.55
2033	4.11	4.14	4.55
2043	4.10	4.14	4.55

PHD = (ERU_{MDD}/1440)[(C)(N)+F]+18, where N is the number of ERUs in the study area, and C and F are coefficients based on the value of N, described in Table 3-1 of the 2020 Water System Design Manual.

Modeling Scenarios

Redmond has an extensive and interconnected distribution system. The system analysis looks for areas of low pressure and deficient fire flows where the existing system cannot provide adequate service during existing and future PHD conditions. The models were used to identify improvements that would increase the distribution system capacity to meet the required level of service for static pressures and fire flows at peak hour during maximum day conditions.

A minimum pressure of 40 psi must be maintained at all customer connections under peak hour demand conditions with operational and equalizing storage depleted in the reservoirs. A minimum of 20 psi must be maintained for fire flows under PHD conditions with operational, equalizing, and fire suppression storage depleted. Additionally, pipeline limiting velocity of 10 fps was used during fire flow conditions. If these criteria could not be met, improvements were identified and through an iterative trial-and-error process, implemented until pressure criteria could be satisfied with a minimum of total pipe and facility additions.

A number of steady state hydraulic analyses were completed for each service area for existing (2023), 10-year and 20-year future demand conditions. These considered pressures and fire flow availability during instantaneous PHD conditions. Table 10-16 describes the modeling scenarios conducted, and the sequence within which they were performed.

Table 10-16. Modeling Scenarios

Description	Demand	Purpose
Existing Peak Hour	2023 Peak Hour Demand	Evaluate system deficiencies
Existing Peak hour and Fire Flow	2023 Peak Hour Demand plus Fire Flow	Evaluate system deficiencies
10 – Year Peak Hour	10 – Year Peak Hour Demand	Evaluate system deficiencies
10 – Year Fire Flow	10 – Year Peak Hour Demand plus Fire Flow	Evaluate deficiencies

Description	Demand	Purpose
20 – Year Peak Hour	20 – Year Peak Hour Demand	Evaluate system and develop CIP for 20-year PHD demand conditions
20 – Year Fire Flow	20 – Year Peak Hour Demand plus Fire Flow	Evaluate system and develop CIP for 20-year PHD conditions during fire flow

10.4.2. Distribution System Evaluation

The hydraulic models were used to evaluate the distribution system under existing and future flows. The four service areas (Well, Rose Hill, Bellevue-Overlake-Viewpoint, and Novelty Hill) are represented in three separate hydraulic model files. For the summary below, the results have been combined to simplify the presentation of results across the City's entire service area.

Peak Hour Demand Results

Figure 10-1 depicts static pressures throughout the Well, Rose Hill, and Bellevue-Overlake-Viewpoint Service Areas under existing peak hour demand conditions. Figure 10-2 and Figure 10-3 present pressures for these same areas under 10-year demand and 20-year demand modeling scenarios The Novelty Hill service area is considered built out and the demands remain constant across all planning scenarios. Figure 10-4, presents static pressures throughout for the Novelty Hill Service Area for existing, 10-year and 20-year demand scenarios.

Existing System Results

Pressures throughout the water system are generally maintained above the 40-psi criterion. There are some exceptions that include the area along NE 104th Street near the Education Hill Reservoirs, where pressures are controlled largely by the water level in these tanks. Based on the ground elevation of approximately 395 feet along 104th Street, the peak hour pressure is between 25 and 30 psi. This low pressure is due to existing topography and is not caused by excessive head loss in the distribution system. During most operational conditions the City is able to maintain the level in the Education Hill tank between 460 and 470, thereby providing pressures of at least 30 psi to customers in this area. This includes a looped pipeline along the Redmond High School. The existing topography along 171st Ave NE (higher elevations) has resulted in lower pressures along the 16-inch line connecting to Redmond Reservoir Park. Another area of deficiency includes pipes located on local high points (for example, NE 88TH place and model junctions that are located just downstream of a PRV at 154th Ave NE and NE 51st Ave). These factors were taken into consideration while proposing improvements and PRV settings were adjusted. Recommended improvements are noted in section 10.4.3.

10-year Peak Hour Demands

Pressure results throughout the water system for this future scenario are similar to those in the existing system scenario. Additionally, the deficiencies include areas on a 20-inch water main along 132nd Ave NE. This location observes a deficiency as it is just downstream of the Rose Hill tank.

20-year Peak Hour Demands

Pressure results throughout the water system for this future scenario are similar to those in the existing system and 10-year peak hour demand scenario. Additionally, low pressures were

observed in the 176th and 177th Ave NE region on the 8-inch looped pipeline in proximity to the Education Hill Reservoirs.

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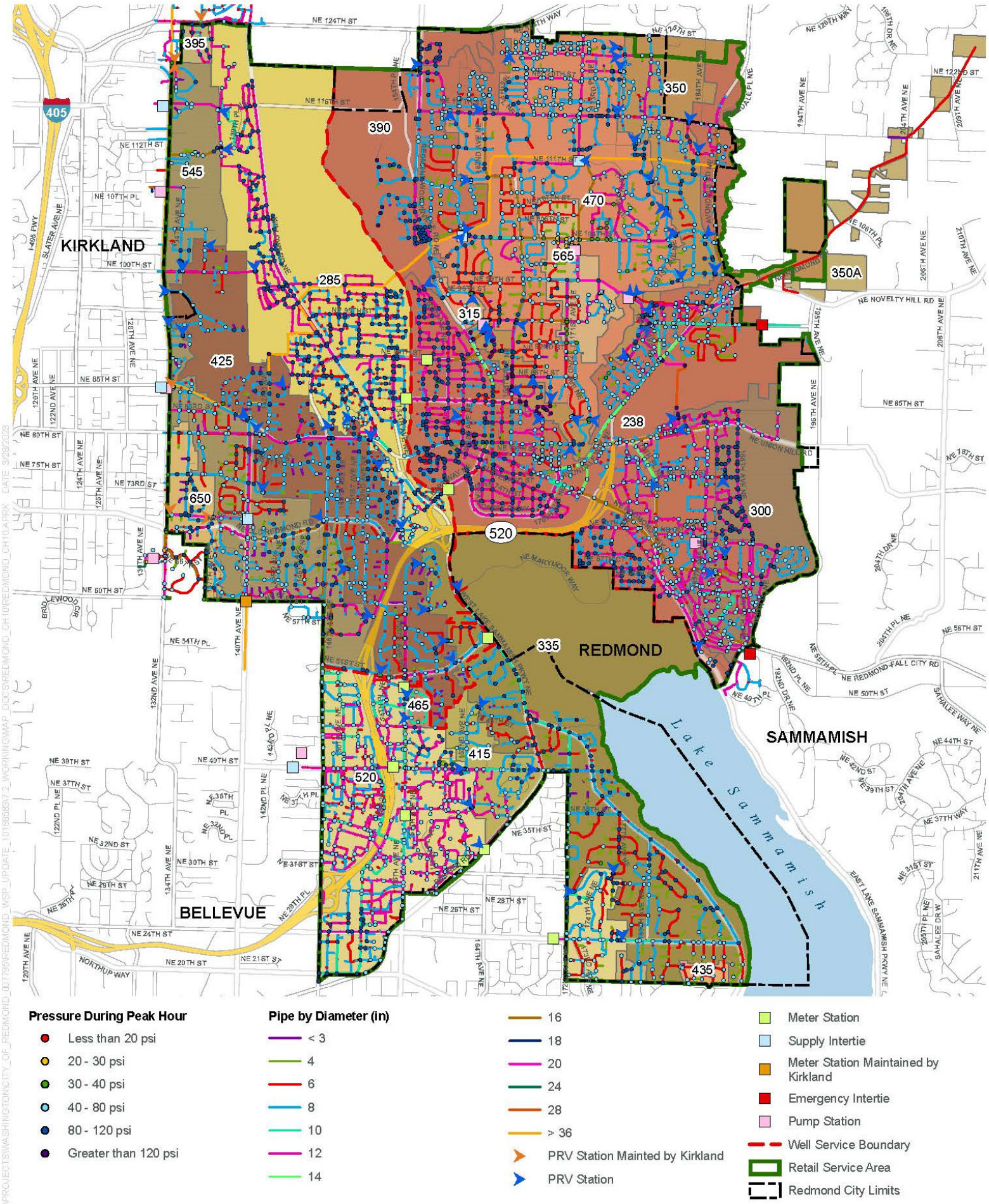

Figure 10-1. Pressure During Peak Hour Demand (Existing)

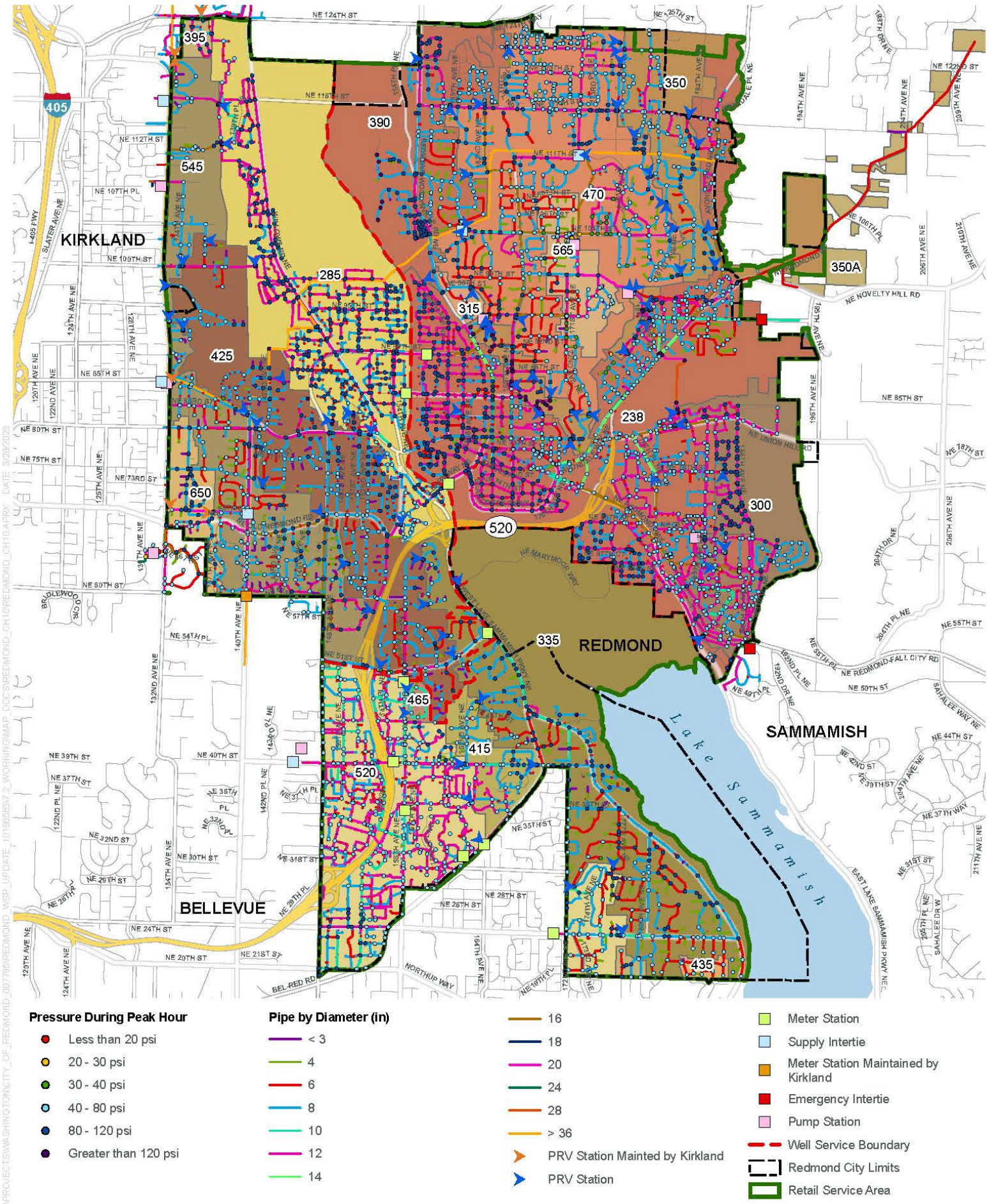

Figure 10-2. Pressure During Peak Hour Demand (10-Year)

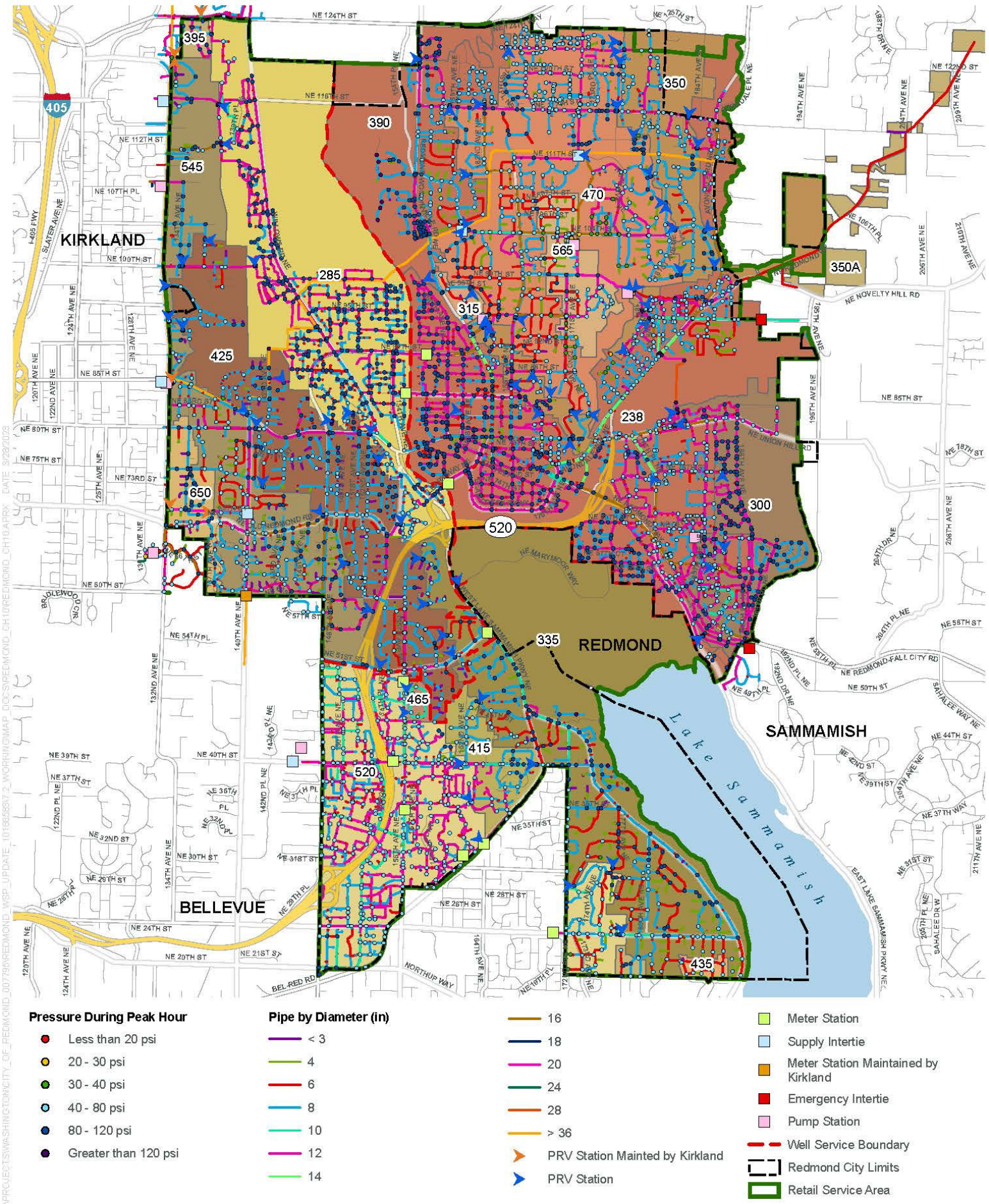

Figure 10-3. Pressure During Peak Hour Demand (20-Year)

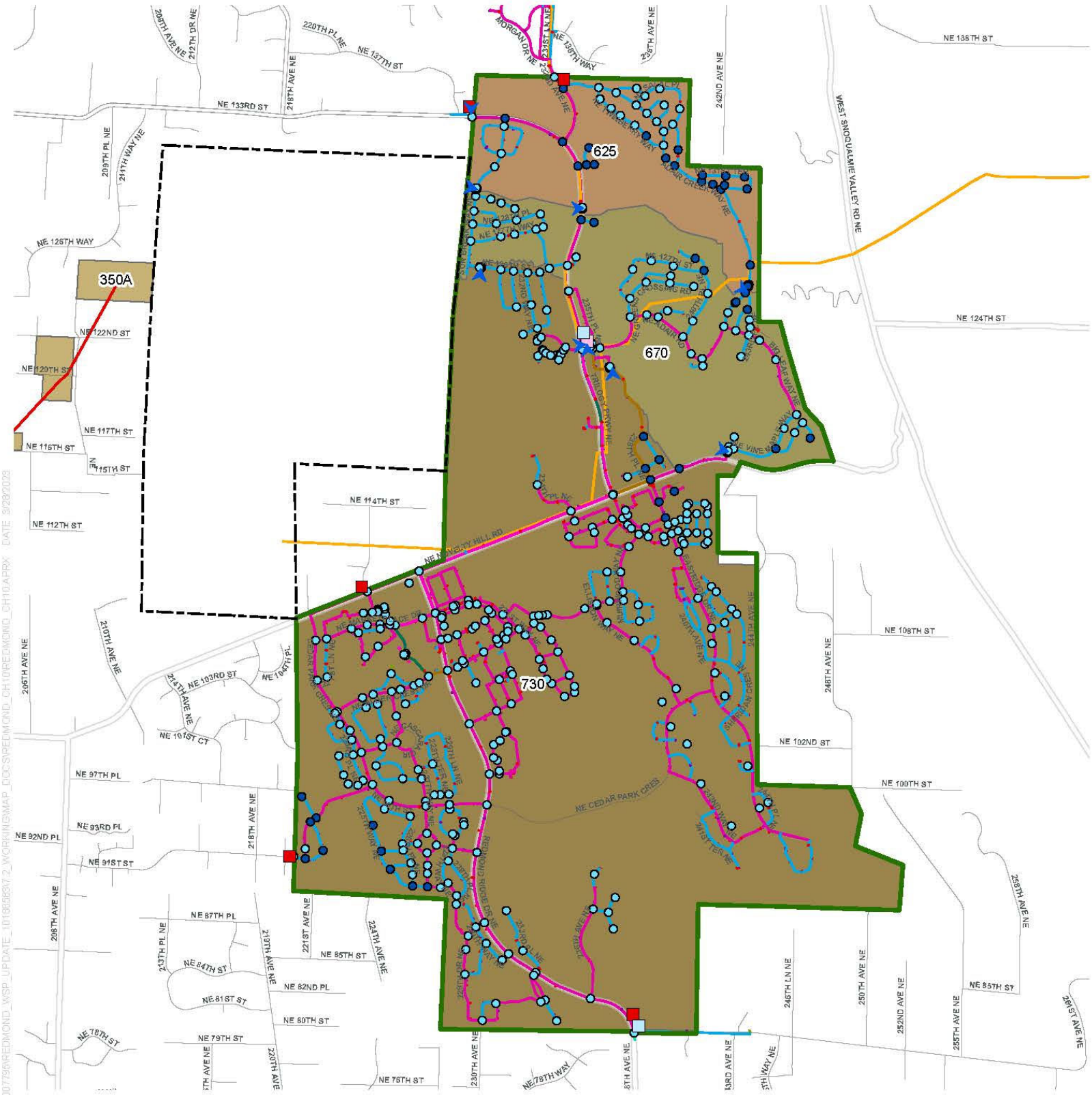

Figure 10-4. Novelty Hill Pressure During Peak Hour Demand

Fire Flow Results

Figure 10-5 depicts available fire flows throughout the Well, Rose Hill, and Bellevue-Overlake-Viewpoint Service Areas under existing peak hour demand conditions.

Figure 10-6 and Figure 10-7 present fire flows for these same areas under 10-year and 20-year future demand conditions. Figure 10-8 presents available fire flows throughout the Novelty Hill Service Area under existing peak hour demand conditions. As the NVH service area is considered built out the available fire flows under 10-year peak hour and 20-year peak hour demand conditions do not change with respective to the existing.

Available fire flows throughout the water system generally exceed required thresholds (i.e., typically 1,500 gpm for residential areas, and 3,500 gpm for nonresidential areas)

Existing System Available Fire Flow Results

There are a few neighborhoods that were developed in the 1970s and earlier that have fire flow availability less than what would be required by the Fire Department if the homes were to be constructed today. Model areas not meeting minimum pressure or maximum velocity criteria and their available fire flows are summarized in Appendix 10-1 for the existing system. These neighborhoods still have the fire flow availability that existed at the time the neighborhood was constructed. The infrastructure in these neighborhoods is 40 years old and aging. Pipes in these parts of the system will eventually be replaced as part of Redmond's water system replacement program. Increased fire flow availability will be a design requirement of those future projects. These neighborhoods with low fire flow availability may be given priority in the pipe replacement program. See Chapter 12, project D-1 for more detail on the City's pipeline replacement program. Junctions not meeting fire flow criteria are listed in Table 1 in Appendix 10-1.

10-year Available Fire Flow Results

As demands increase, the fire flow results show increasing numbers of deficiencies. The available fire flows are presented in

Figure 10-6 and hydrant nodes that do not meet criteria are summarized in Table 2 of Appendix 10-1.

20-year Available Fire Flow Results

As demands increase, the fire flow results show increasing numbers of deficiencies. The available fire flows are presented in Figure 10-7 and hydrant nodes that do not meet criteria are summarized in Table 3 of Appendix 10-1. The 20-year peak hour and fire flow demand condition using both pressure and velocity constraints was considered as the worst-case scenario on the existing system. Additional analyses were done to distinguish between the two criteria. Figure 10-9 depicts the deficiencies for this scenario and indicates if the deficiency is caused due to the maximum 10 fps velocity constraint or the 20-psi minimum pressure constraint. Improvements were identified to resolve all hydrant nodes that fail criteria for the 20-year peak hour demands and fire flow conditions.

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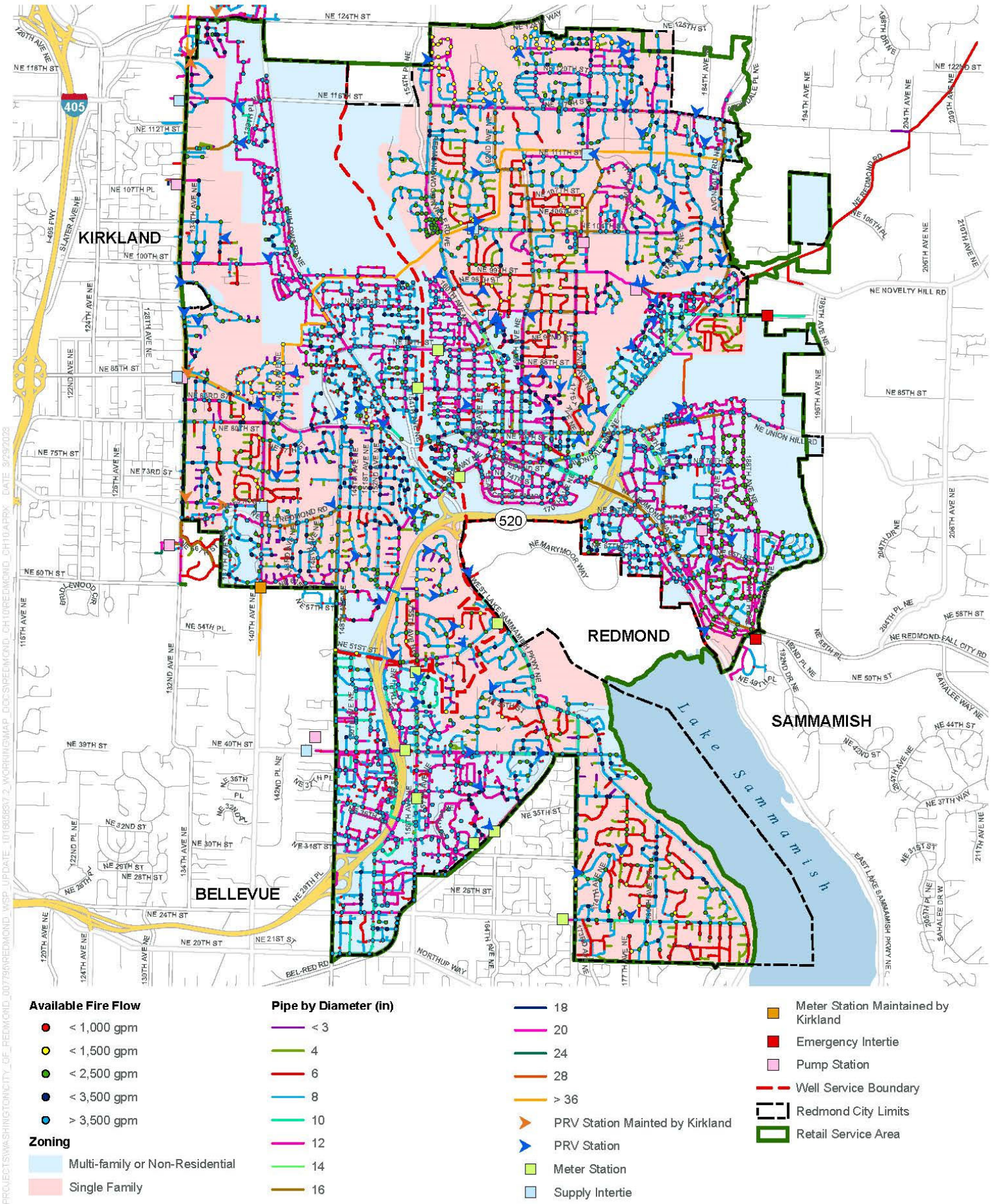

Figure 10-5. Available Fire Flows During Peak Hour Demand (Existing)

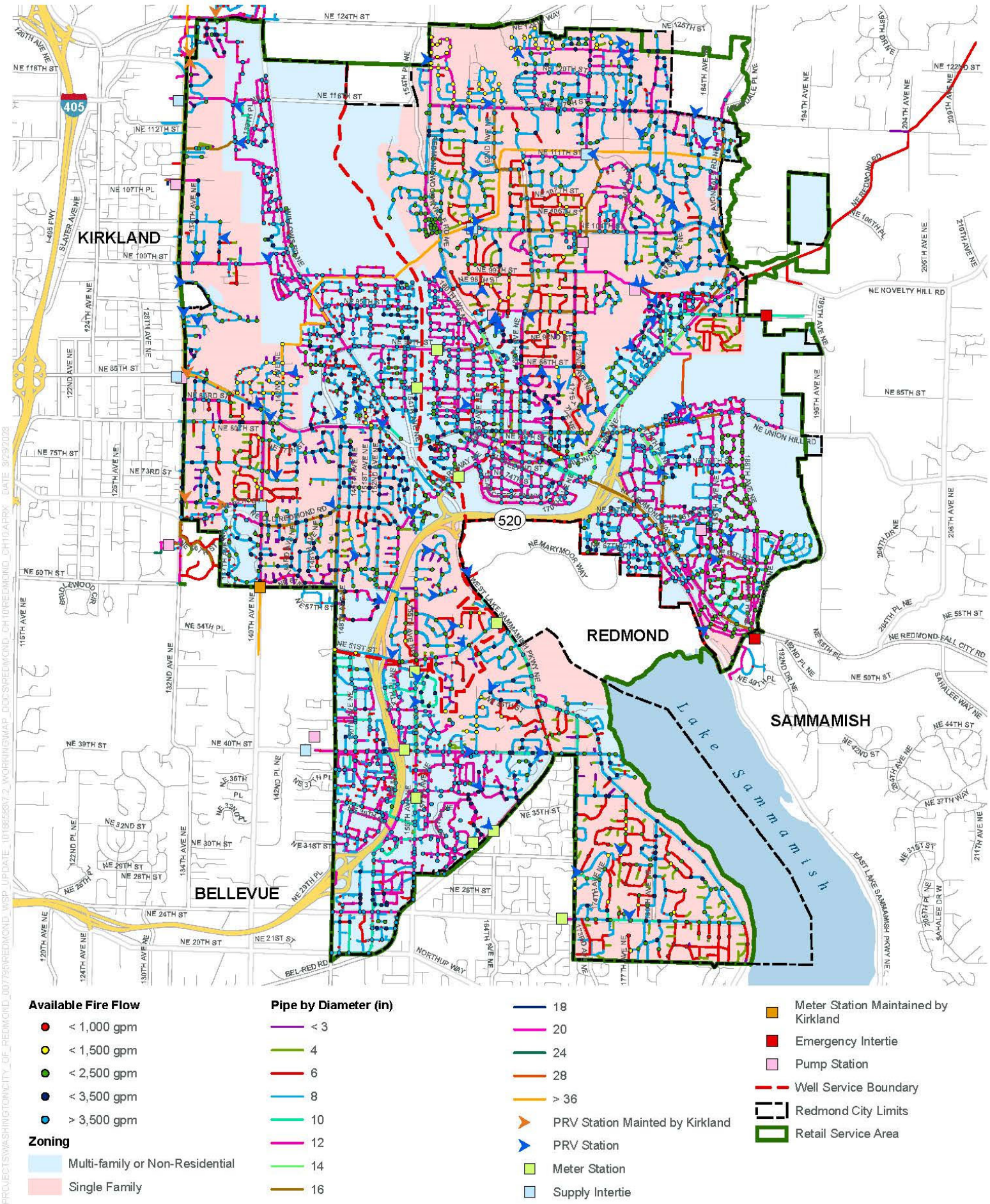

Figure 10-6. Available Fire Flows During Peak Hour Demand (10-Year)

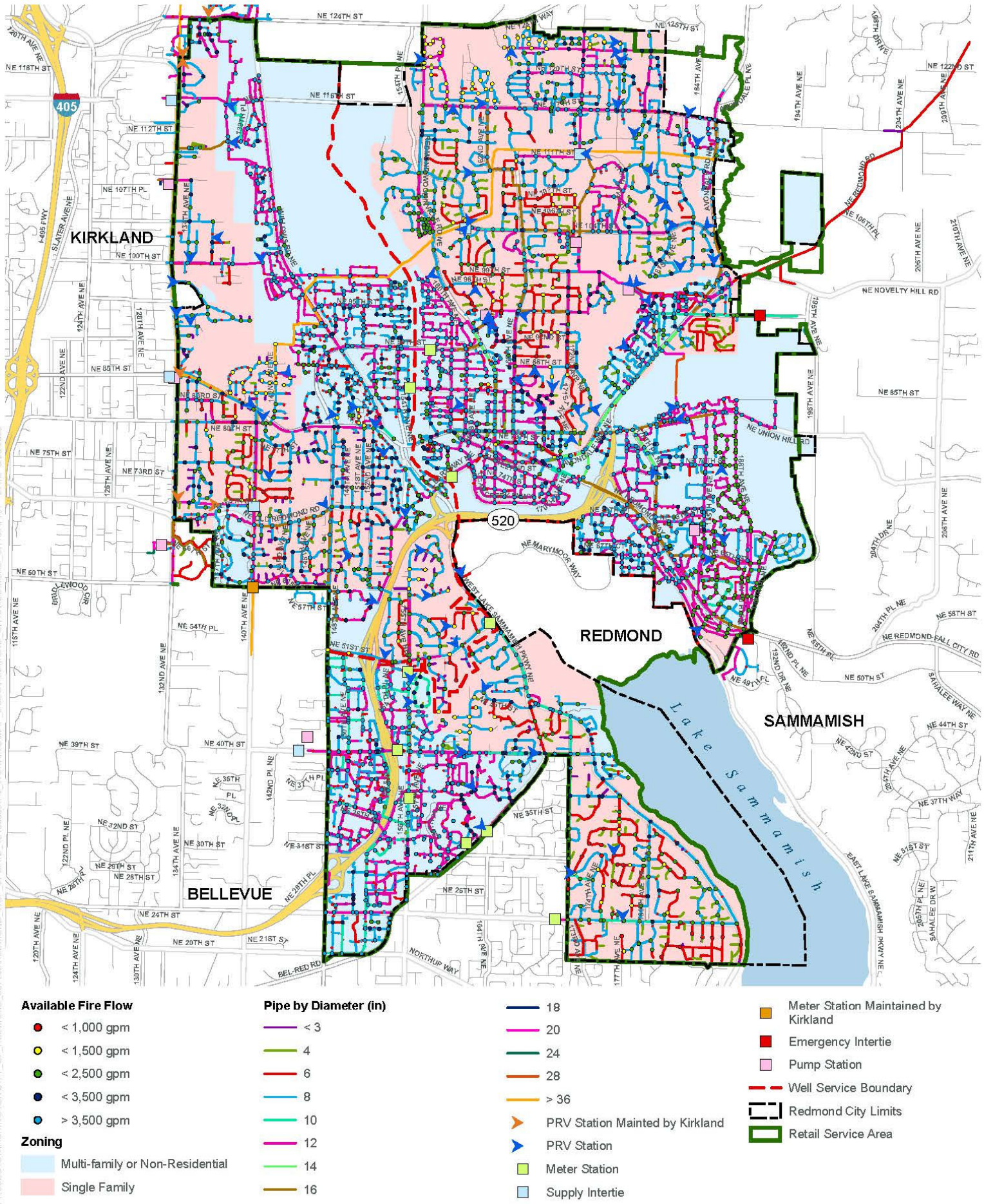

Figure 10-7. Available Fire Flows During Peak Hour Demand (20-Year)

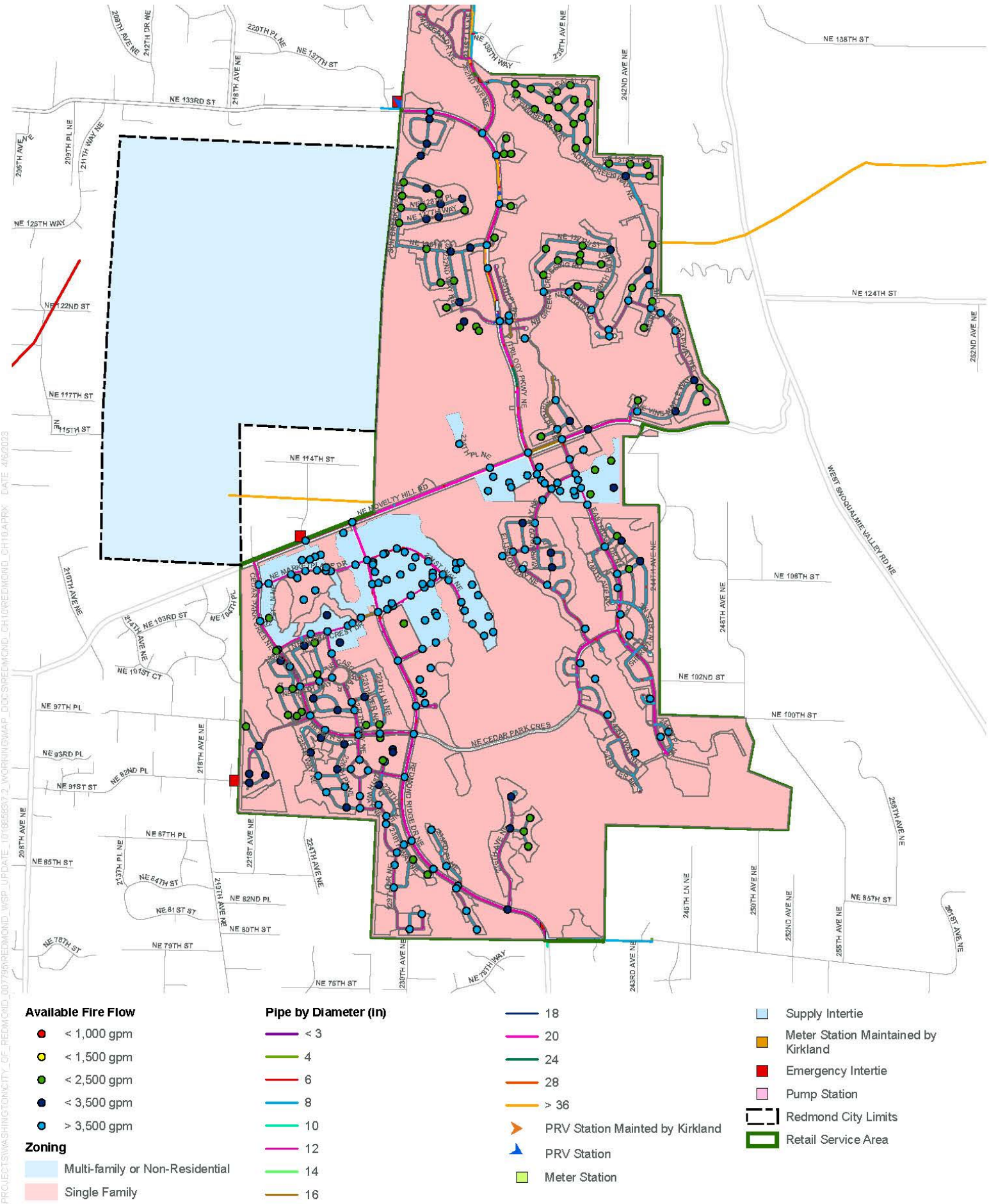

Figure 10-8. Novelty Hill Available Fire Flows During Peak Hour Demand

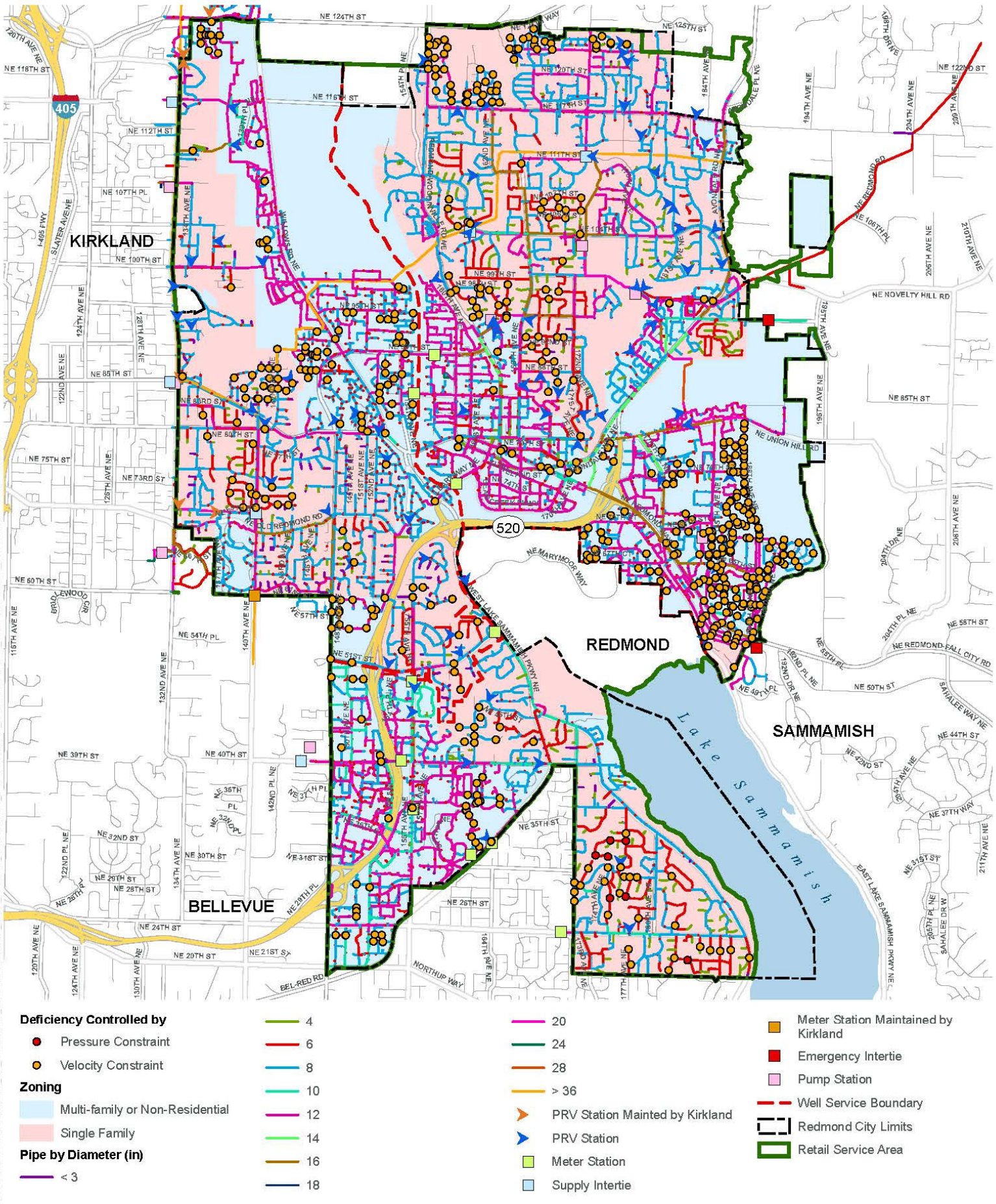

Figure 10-9. Fire Flow Deficiencies at 20-Year Peak Demand

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10.4.3. Distribution System Proposed Improvements

The existing system models were analyzed under 20-year PHD plus fire flow conditions (worst case) for the Well, Rose Hill, and Bellevue-Overlake-Viewpoint Service Areas. Based on the model results, improvements were developed to address areas of the system failing the evaluation criteria. Proposed improvements include upsizing pipes, updating PRV settings, and evaluating boundary conditions that will need to change to supply additional flow in the future. To propose improvements, fire flow analysis was conducted on all model nodes that represent hydrants excluding nodes around pumps stations, tanks and PRVs. Along with these distribution pipes were excluded from velocity criterion. Model improvements suggested for corresponding hydrant deficiencies have been listed in the Table 4 of Appendix 10-1 and shown in Figure 10-10.

The proposed pipeline improvements (upsizing) shown in Table 4 of Appendix 10-1 are organized according to priority, as follows:

- Priority Level 1 (High) - Project resolves at least one node having a pressure deficiency (i.e., less than 20 psi) under fire flow conditions.
- Priority Level 2 (Medium) - Project resolves at least one node deficiency where the velocity constraint creates a deficiency greater than 70% of fire flow requirement.
- Priority Level 3 (Low) - Project resolves at least one node deficiency where the velocity constraint creates a deficiency between 30 to 70% of fire flow requirement.
- Priority Level 4 (Very Low) - Project resolves at least one node deficiency where the velocity constraint creates a deficiency less than 30% of fire flow requirement.

The intent of this prioritization is to inform how the City identifies and prioritizes piping upgrades in its broader pipeline replacement program. See Project D-1 in Chapter 12 for more detail.

Improvements categorized as high priority (i.e., level 1) mainly lie in the southeast region of the BOV service area. This region also experiences high pipe velocities, triggering improvements in other priority levels as well. Increasing pipe sizes to resolve velocity criteria helps the system with pressure issues too. Thus, it is important to note that while high priority pipe improvements will improve pressures in the region significantly, they may not be the only ones that will be needed to fully resolve pressure issues.

The Well, Rose Hill model area pipeline improvements are summarized in Table 4 of Appendix 10-1. The majority of the deficiencies in this service area are due to velocity criteria (maximum pipe velocities of 10 fps during peak hour demand and fire flow conditions) or a combination of velocity and pressure criteria. To resolve these issues, appropriate upsizing for the pipes was identified to lower distribution system velocities and headloss. Additionally, to address deficiencies due to residual pressure or low zone pressure, PRV settings were adjusted in some instances. For example, to resolve a pressure criteria deficiency downstream of PRV-6a and PRV-6b which connect zone 470 to 315 along NE 98th street, PRV HGL settings were increased to 314 ft to account for general system headloss. In addition, for PRV 66a and PRV-6b, located at NE 92ND Way, PRV HGL settings were increased to 417 ft to increase head in the 425 zone. These changes to the PRV HGL settings did not create any high pressure issues during low demand periods.

Additionally, fire flow analysis depicted deficiencies at non-hydrant junctions located at higher elevations. These are areas where the system will experience low pressures due to the

topography. The City plans for fire flow to be provided at such locations, where there are hydrants present, through the use of a pumper truck or mobile fire engine.

In the Bellevue-Overlake-Viewpoint Service Area, extremely low pressures due to supply to the 520 zone were observed. This zone is shared with the neighboring Bellevue system, part of which is included in the City's hydraulic model (BOV). A possible solution is to increase supply from the Holt aqueduct at the location where the current North 40th Street Pump Station connects to the 520 zone. Model analysis estimated about 15 million gallons per day of flow would be required through this connection to solve basic pressure problems for the Redmond 525 zone. Most of the deficiencies in this area are due to local velocity issues, but additional supply is needed to address overall pressures in the system.

Novelty Hill Area does not experience any system deficiencies for 20-year peak hour demand conditions and available fire flows throughout its service areas.

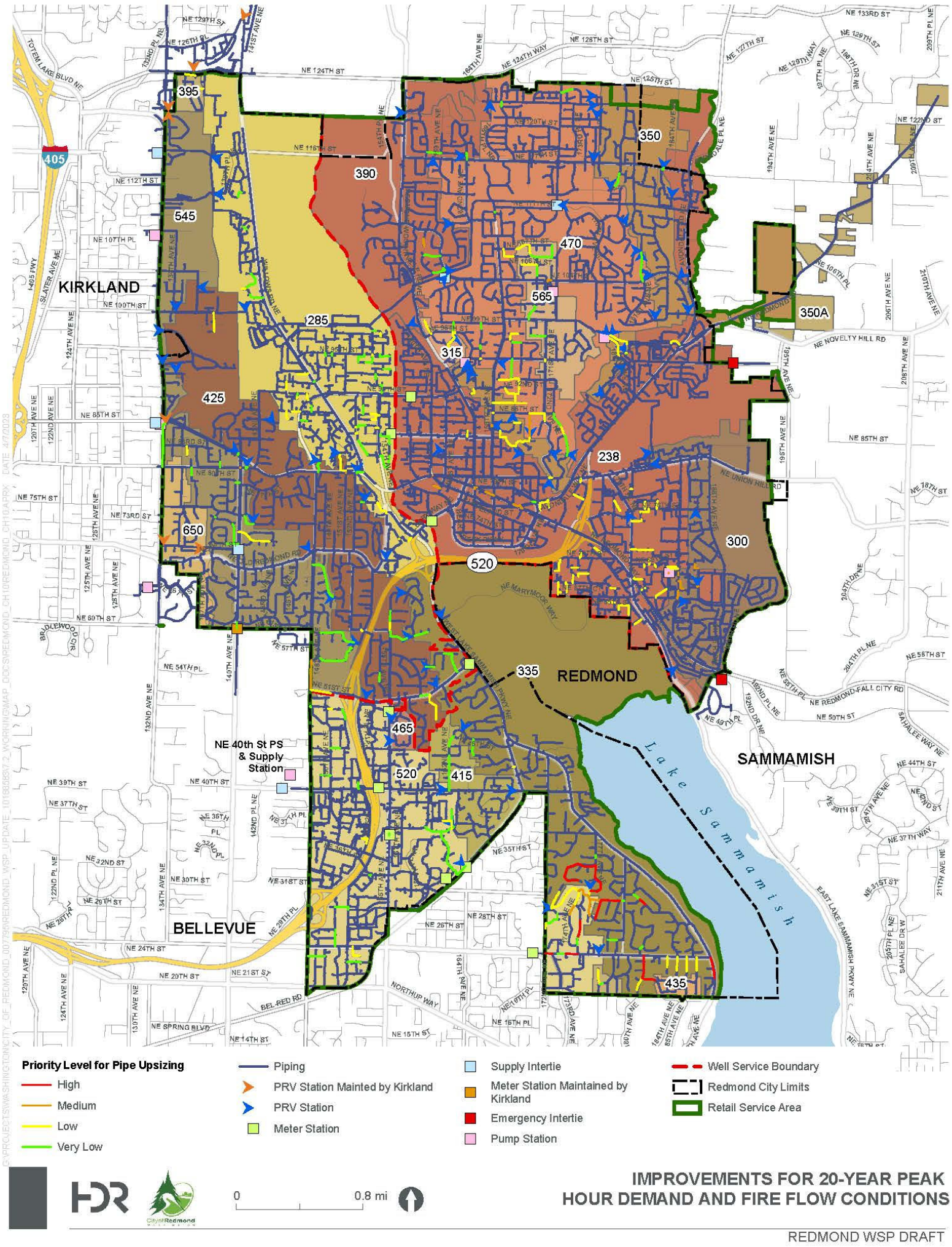

Figure 10-10. Improvements Proposed for 20-year Peak Hour Demand conditions and Available Fire Flows

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10.5. ERU Capacity Summary

The analyses presented in this chapter provide the limiting factors for the system's capacity. Table 10-17 displays the ERU capacity summary for the In-City Service Area and Table 10-18 displays the same information for the Novelty Hill service area. In both service areas, standby storage is the limiting factor for system capacity.

Table 10-17. ERU Capacity Summary – In-City Service Area

Service Classification	Total MDD for the classification, gpd [1]	Total # Connections in the classification [2]	ERUs [3]
Single-Family	5,217,288	12,331	12,542
Multi-Family	4,718,354	1,316	11,342
Non-Residential	2,579,854	1,255	6,202
Irrigation	2,324,095	579	5,587
Fire	589	570	1
Exempt	406,234	N/A	977
Non-revenue	576,135	N/A	1,385
Total existing ERUs = 38,036			
Physical Capacity as ERUs			
Water System Component (Facility)	**Calculated Capacity in ERUs for each component**		
Source(s)	140,808 [4]		
Treatment	NA [5]		
Equalizing Storage	97,527 [6]		
Standby Storage	39,485 [7]		
Transmission	N/A [4]		
Water Rights	N/A [8]		
Water System Physical Capacity (ERUs) = 39,485 [9] (based on the limiting water system component shown above)			

[1] Based on year 2021 demands from billing data.

[2] Based on number of connections in year 2021 (Table 4-4).

[3] Calculated using the MDD ERU factor for the City service area (416 gpd). The number of single family connections does not match the number of ERUs because the ERU factors is the average from 2019 - 2021, and therefore does not correspond exactly to the ERU value in 2021.

[4] Based on total capacity of wells and interties (approximately 58.6 mgd).

[5] This category does not apply; water treatment occurs at the wells at the rate of source production or is treated by SPU before it arrives at the interties.

[6] Based on the maximum ERUs that can be served at 40 psi, as described in the storage analyses.

[7] Based on the maximum ERUs that can be served from pumped standby storage, as described in the storage analyses.

[8] The City purchases water from Cascade Water Alliance, independent of the City's water rights, to supplement the groundwater sources. Therefore, water rights are not a limiting factor.

[9] Standby storage is the current limiting factor. This table indicates that 2021 demands were within the physical capacity limitations of the system. Per the information in Table 10-10, the standby storage capacity is forecast to be insufficient by 2023. This deficiency is based on the City's standby storage standard of 400 gpd/ERU rather than DOH's planning standard of 200 gpd/ERU. Using the DOH standard, no deficiencies are forecast in the 20-year planning horizon.

Table 10-18. ERU Capacity Summary - Novelty Hill Service Area

Service Classification	Total MDD for the classification, gpd [1]	Total # Connections in the classification [2]	ERUs [3]
Single-Family	1,251,470	3,296	3,297
Multi-Family	227,887	80	600
Non-Residential	102,417	73	270
Irrigation	177,635	64	468
Fire	3	4	0
Exempt	48,162	N/A	127
Non-revenue	43,635	N/A	115
Total existing ERUs = 4,877			
Physical Capacity as ERUs			
Water System Component (Facility)	**Calculated Capacity in ERUs for each component**		
Source(s)	24,974 [4]		
Treatment	NA [5]		
Equalizing Storage	19,284 [6]		
Standby Storage	7,618 [7]		
Transmission	N/A [4]		
Water Rights	N/A [8]		
Water System Physical Capacity (ERUs) = 7,618 [9] (based on the limiting water system component shown above)			

[1] Based on year 2021 demands from billing data.

[2] Based on number of connections in year 2021 (Table 4-4).

[3] Calculated using the MDD ERU factor for the Novelty Hill service area (380 gpd). The number of single family connections does not match the number of ERUs because the ERU factors is the average from 2019 - 2021, and therefore does not correspond exactly to the ERU value in 2021.

[4] Based on total capacity of wells and interties (approximately 11.4 mgd).

[5] This category does not apply; water treatment occurs at the wells at the rate of source production or is treated by SPU before it arrives at the interties.

[6] Based on the maximum ERUs that can be served at 40 psi, as described in the storage analyses.

[7] Based on the maximum ERUs that can be served from standby storage at 20 psi.

[8] The City serves this system exclusively with purchases from Cascade Water Alliance. Therefore, water rights are not a limiting factor.

[9] Standby storage is the current limiting factor.

Chapter 11: Operation and Maintenance Program

City of Redmond 2023 Water System Plan DRAFT

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11. Operation and Maintenance Program

The City has developed many specific plans and programs to operate and maintain its water system. These plans and programs are referenced in this section and critical elements are attached as appendices. This section includes a brief summary of the overall operation and maintenance of the water system and those specific plans and programs.

11.1. Water System Management and Personnel

The City's water system is administered according to Redmond Municipal Code Title 13 and is under the direction of the Public Works Director. Management of the water utility is separated into multiple divisions within the Public Works Department, with most oversight and management provided by staff in the Environmental and Utilities Services Division (EUSD) and the Maintenance and Operations Division. Figure 11-1 shows the organizational structure of the City's Public Works Department.

EUSD is managed by the Public Works Deputy Director, Environmental and Utility Services Division. Within EUSD, the Utility Engineering Group is responsible for the planning and design of water system improvements. The Utility Engineering Group consists of a utility engineering manager, civil engineers, and planners. The group also has support from engineering technicians, and administrative coordinators in other work groups.

The Construction Group, also within Public Works, primarily provides construction management for City projects and inspection services for public projects undergoing construction.

The Development Services Engineering Division, within the Planning Department, oversees the review of new private development projects, and coordinates with the EUSD engineers to ensure that utility infrastructure in new developments is appropriately designed and will be adequately served by the City's water system.

The Maintenance and Operations Division is managed by the Public Works Deputy Director, Maintenance and Operations. This division supports five maintenance groups in the Public Works Department, including the Water Maintenance Group. The Water Maintenance Group operates and maintains the City's water facilities. The group currently includes two supervisors (Operations and Water Quality), a water quality analyst, a cross-connection specialist, two utility system technicians, and 12 maintenance technicians for a total of 18 full-time employees.

The responsibilities of the Water Maintenance Group and support staff include inspection, treatment, testing, installation, and repair of system facilities; routine operation and preventive maintenance; meter reading; record keeping; administrative tasks; general clerical work; and corrective or breakdown maintenance as required in response to emergencies.

11.1.1. Personnel Responsibilities

Members of the water system staff have been assigned specific areas of responsibility dependent on their skill. The key responsibilities of the water system staff are summarized below.

Planning

- **Development Services Engineering Manager –** Oversees review of all proposed private development projects within the City.

Public Works

- **Director –** Directs and oversees the activities of all divisions of the Public Works Department.

Environmental and Utilities Services Division

- **Deputy Director, EUSD** Directs and oversees the activities of EUSD, including Engineering, Environmental Programs and Science and Data Analytics.
- **Utility Engineering Manager –** Plans, manages, and directs the City's water, stormwater and wastewater projects. Also serves as a liaison to Cascade Water Alliance, and coordinates many of the business functions of the utility.

Operations Division

- **Deputy Director, Operations** – Directs and oversees maintenance and operations activities of the wastewater, stormwater, water, streets, and fleet maintenance groups.
- **Maintenance Manager** – Plans, manages, and directs the City's maintenance and operations of water, wastewater and stormwater systems.
- **Water Maintenance Group**
    - **Supervisor, Operations –** Coordinates and supervises maintenance crews responsible for the repair, installation, and operation of the City water system.
    - **Supervisor, Water Quality –** Coordinates and supervises maintenance staff responsible for water quality and treatment, including City wells and reservoirs.
    - **Lead Water Quality Technician –** Coordinates, schedules, and reviews work in the Water Quality Section. Assists EUSD as needed on capital projects.
    - **Utility System Technician -** Operates, maintains, repairs, and monitors the pumps, telemetry system, and chemicals used in water treatment.
    - **Water Quality Technician –** Inspects, tests, and monitors backflow prevention devices as part of the cross-connection control program. Serves as authorized plumbing inspector for cross-connection inspection and enforcement. Conducts coliform monitoring, and operates, maintains, and repairs telemetry system, as needed.
    - **Lead Maintenance Technician –** Assigns and directs the work of individuals and crews in manual work and operation of equipment used in the maintenance of the water system. Performs more complex maintenance and equipment operations.
    - ~~**Senior**~~ **Maintenance Technician –** Operates heavy and specialized equipment and performs maintenance, repair, and installation required for the effective operation of the City's water system. Assists in training and directing other employees in equipment operations and maintenance activities.

Aaron Bert
Public Works Director

Linda Keefe
Business Analyst

Anne-Marie Marshall-Dody
Deputy Director-Utilities & Environmental Programs

Tess Sturtevant
Department Administrative Coordinator

Amanda Balzer
Manager
SCIENCE & DATA ANALYTICS

Jessica Atlakson
Jessica Pfundt
Environmental Scientist

Cynthia Brown
Don Swayne
GIS Analyst, Sr.

Curtis Nickerson
Sr. Environmental Scientist

Joe Plattner
Business Analyst

Steve Hitch
Manager
ENGINEERING

Vacant
Engineer

Emily Flanagan
Jeff Thompson
Lisa Rigg
Cindy Wellborn
Engineer, Sr.

Tom Hardy
Planner, Sr.

Aaron Moldver
Manager
ENVIRONMENTAL PROGRAMS

Eberley Barragan
Stacey Auer
Ken Waldo
Scott McQuary
Tally Greulich
Micah Bonkowski
Program Administrator

Peter Holte
Anne Dettelbach
Planner, Sr.

Jon Spangler
Engineering Manager
CONSTRUCTION

Tess Wilkinson
Betsie McLain
Program Coordinator

INSPECTION
Joe Averill
Supervisor

Rich Halvorsen
Lead Inspector

Mike Phillips
Cedric Feze
Vacant
Inspector

James LaCourse
Engineer Associate

CONSTRUCTION
Steve Gibbs
Supervisor

John Mork
Lisa Singer
Joseph O'Leary
Eric Dawson
Rob Crittenden
Bassam Al-Ali
Mike Haley
Aaron Noble
Engineer, Sr.

Vacant
Colin Sherrill
Engineer

Paul Cho
Engineering Manager
TRAFFIC ENGINEERING SAFETY & OPERATIONS

Patty Criddle
Engineering Supervisor

Hidemi Tsuru
Adnan Shabir
Vacant
Engineer, Sr.

Chang Liu
Engineer

Yuri Bergeron
Engineer Tech, Sr.

Gina Schroeder
Program Administrator

Marilee Crivello
ROW Engineer Tech, Sr.

Ilir Dardania
ROW Lead Inspector

Vacant
Signals Supervisor

Dan Kerr
ITS Network Technician

Julian Stewart
Lead Traffic Signal Technician

Thomas Fields
Joseph Frezza
Traffic Signal Technician

Figure 11-1. City of Redmond Public Works Organization Chart

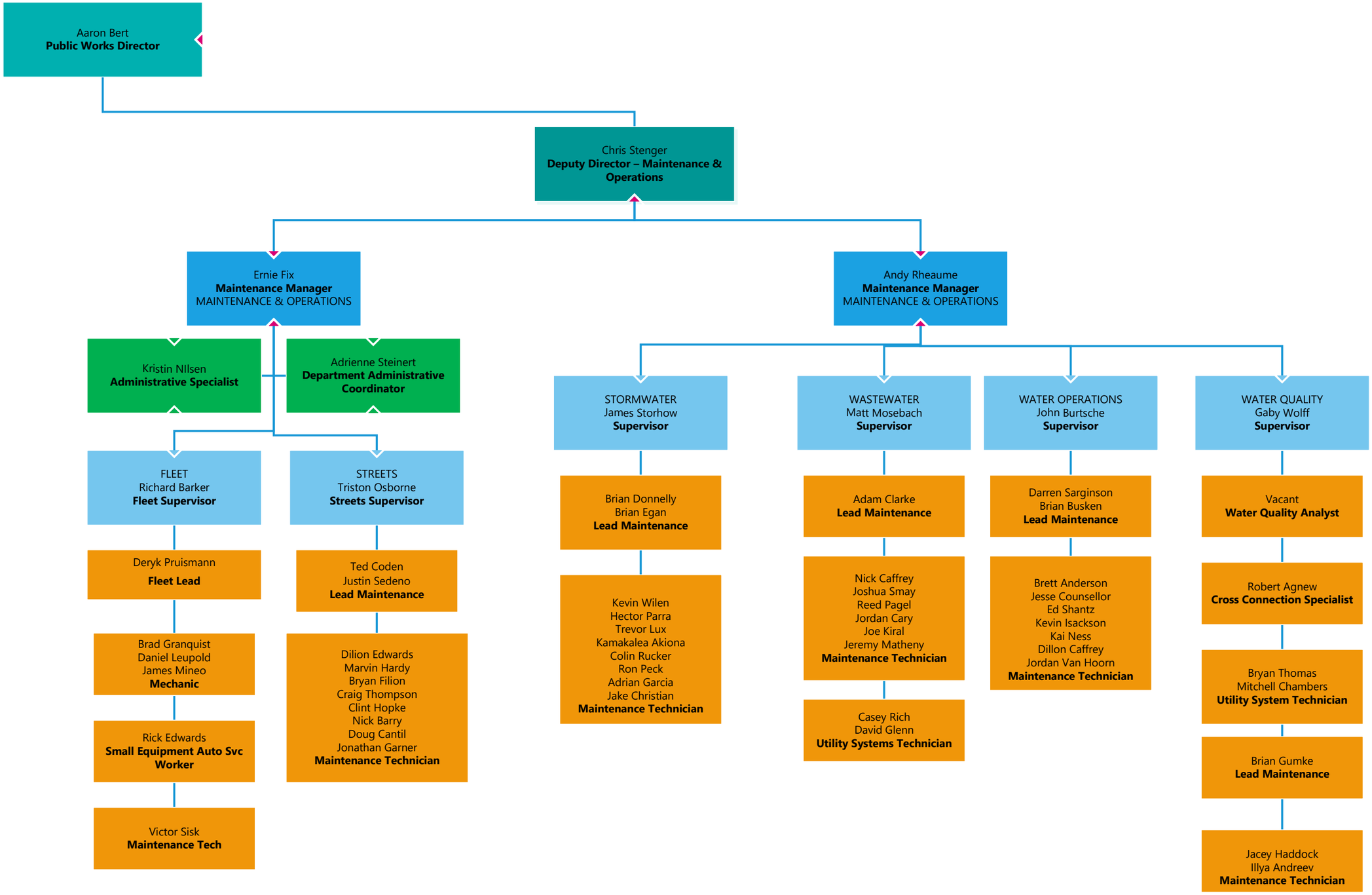

Figure 11-1. City of Redmond Public Works Organization Chart

11.1.2. Operator Certification

In accordance with Chapter 70.120 RCW, a certified operator is required for Group A public water systems. Under Chapter 70.120.030, certified operators shall be in charge of the technical direction of a water system's operation, or an operating shift of such a system, or a major segment of a system necessary for monitoring or improving the quality of water. Chapter 246-292 WAC provides the requirements for water works operator certification. City personnel designated as operators are required to be certified upon hiring, or to complete certification within one year of their start of employment with the City. The City supports and encourages in-house training and external training opportunities for operators, for continuing education.

Table 11-1 shows certification information for the water utility maintenance staff.

Table 11-1. Operations Division Water Utility Personnel Certification

Position	Name	Certification
Supervisor, Operations	John Burtsche	Water Distribution Manager 4, Cross-Connection Specialist
Supervisor, Water Quality	Gaby Wolff	Water Distribution Manager 4, Water Treatment Operator IT 2, Cross-Connection Specialist
Water Quality Analyst	Dylan Herndont	Water Distribution Manager 3, Water Treatment Operator 3, Cross-Connection Specialist
Cross Connection Specialist	Robert Agnew	Water Distribution Manager 1, Cross-Connection Specialist
Lead Maintenance Technician	Darren Sarginson	Water Distribution Manager 1 Cross-Connection Specialist
Lead Maintenance Technician	Brian Busken	Water Distribution Manager 1
Lead Water Quality Technician	Brian Gumke	Water Distribution Manager 3, Cross-Connection Specialist
Utility System Technician	Bryan Thomas	Water Distribution Manager 2, Cross-Connection Specialist
Utility System Technician	Mitchell Chambers	Water Distribution Manager 2, Cross-Connection Specialist
Maintenance Technician	Brett Anderson	Water Distribution Manager 2
Maintenance Technician	Jesse Counsellor	Water Distribution Manager 1
Maintenance Technician	Jordan Van Hoorn	Water Distribution Manager 1
Maintenance Technician	Ed Shantz	Water Distribution Manager 1, Cross Connection Specialist
Maintenance Technician	Kevin Isackson	Water Distribution Manager 2
Maintenance Technician	Kai Ness	Water Distribution Manager 1
Maintenance Technician	Dillon Caffrey	Water Distribution Manager 1
Maintenance Technician	Vacant	
Maintenance Technician	Jacey Haddock	Water DIstribution Manager 1

Position	Name	Certification
Maintenance Technician	Illya Andreev	Water Distribution Manager 2, Cross-Connection Specialist

Maintenance duties have been divided among four lead individuals, with each lead individual responsible for assigning crew activities in accordance with specific areas of expertise. Table 11-2 provides a breakdown of work responsibility by lead.

Table 11-2. Operations Division/Water Maintenance Group Lead Staff Responsibilities

Water Quality Analyst Dylan Herndon	Lead Maintenance Technicians Darren Sarginson & Brian Busken	Lead Water Quality Technician Brian Gumke
Water Quality Compliance with SDWA Bacteria Inorganics VOCs pH Fluoride Chlorine Consumer Confidence Reports **Telemetry** Repair Monitoring Control **Wells** Inspection Cleaning Operation Chemical additions **Miscellaneous** Cross-connection control	**Mains** Flushing Repairs Extensions Valves Locates **Hydrants** Records Inspection Repair Painting **Services** Repairs Installs Modifications **Valves** Inspection Operation PRVs Altitude **Plat & Capital** Shutdowns Inspection Specifications Standards **Miscellaneous** Pressure information Lucity work orders Blow-offs Air-Vacs Asphalt repair Novelty Hill Operations	**Meters** Installation Replacement Testing and calibration Reading Leaks Turn on/Shut off Door hangers Final bills Compound meters AR99 reading software Reading hardware Service disconnects **Wells** Control Valves Motors Pumps **Reservoir** Levels Cleaning

11.2. Major System Components and Routine System Operation

Major system components of the City's water system are inventoried in Section 2. Routine system operations include checking system facilities, daily monitoring of the telemetry system at

the Maintenance and Operations Center (MOC), and responding to customer inquiries and complaints. Monitoring and operation of major system components, including reservoirs, wells, pump stations, and supply stations, are accomplished in part through telemetry and a centralized control system located at the MOC.

Each major system component has a hardcopy operation and maintenance manual that describes standard and alternative modes of operating the facility. In addition, the City's goal is to have all operations information available electronically in a similar format for each facility. That process has begun, and the City has electronic manuals for several of its facilities, including the Novelty Hill area system components. All CIP projects are required to provide an electronic file folder that contains all project information, project drawings, and any data about new or renovated facilities.

The City also implemented a significant upgrade to its water and wastewater SCADA system in 2008 consisting of conversion to a Wonderware software and installation of new hardware components. The result of the project was a more sophisticated system allowing staff a greater level of control and information management regarding the system's many components. Additional upgrades occurred in 2016 to improve backup communication abilities at the MOC and Lift Station 17.

11.3. Preventative Maintenance Program

The City has a preventative maintenance program that has kept the water system operating with very few breakdowns or emergencies. Capital improvement programs (CIP) continue to concentrate on specific system improvements that eliminate old piping and improve system operation.

Preventative maintenance consists of regularly servicing pumps and motors, pressure reducing stations, and hydrants; inspecting valves; mapping locations of facilities; testing meters for accuracy; cleaning and painting reservoirs and exposed equipment; and flushing dead-end pipelines. Table 11-3 provides a summary of routine and preventative work activities for the water maintenance staff.

Table 11-3. Preventative Maintenance Work Schedule

Asset/Equipment	Daily	Weekly	Monthly	Annually	As Required
Wells	Inspected & maintained				
Booster stations		Inspected & maintained			
Reservoirs		Inspected		Inspected annually; Cleaned every 6-8 years	Painting, typically every 15 years
Telemetry	Monitoring & recording	Recording	Recording	Recording	
Mains					Replaced or repaired as part of CIP Program
Valves				Operated during flushing program, 8 year inspection cycle	Repaired or installed, inspected and recorded as schedule permits
Services					Repaired or installed
Meters			Residential routes read Bi-monthly, Commercial read monthly	Commercial meters (3" and larger) tested annually	Repaired or installed
Pressure-reducing, altitude, pump-control, & pressure relief valves				Inspected, adjusted, or repaired 20 PRV full rebuilds per year on 5-year cycle	Repaired
Hydrants				1,400 Hydrants Inspected per year on 3-year schedule	Repaired or installed
Flushing				All service areas and wells	Water Quality complaints
Cross-connection			Notifications for testing		Inspected and recorded

11.4. Equipment, Supplies, and Chemical Listing

The Maintenance and Operations Division maintains a detailed inventory of equipment, supplies, and chemicals, including required Safety Data Sheets (SDS).

11.5. Comprehensive Water Quality Monitoring Plan

To ensure that the City's drinking water is kept safe and that adequate public health protection is maintained, the City has a water quality monitoring program. This program includes testing at sites across the City including the wells, and specific locations in the distribution system. The monitoring program meets Washington State Department of Health (DOH) requirements defined in Washington Administrative Code (WAC) 246-290-300, which includes requirements for sampling and testing of a minimum of 100 bacteriological samples per calendar month for a daytime population served of approximately 125,000.

The City of Redmond conducts water quality monitoring for physical and chemical parameters in accordance with the schedule provided in Table 11-4. Monitoring is conducted at these locations using the chemical/physical criteria and frequency shown in the table. Chlorine residual, fluoride, hardness, temperature, and pH are all tested in-house by City staff. The City adheres to the Coliform Monitoring Plan for bacteriological monitoring and follow-up requirements (Appendix G). For all other water quality tests, City staff collects the necessary samples and sends them to a certified laboratory, which are listed in Section 8.7. Water quality test results from 2011 – 2022 are summarized in Chapter 8.

Seattle Public Utilities conducts water quality monitoring for the surface water supplies delivered to the City of Redmond through the regional transmission system.

Table 11-4. Water Quality Monitoring Schedule

Location	Daily		Weekly			Annually	Quarterly	3 Years				6 Years			9 Years			Other[1]		
	Cl_2	NaF	Bacteria	pH	Temp	Nitrate	TTHM/HAA5	Pb & Cu	PFAS	SOCs	VOCs	Radionuclides	SOCs	VOCs	Asbestos	IOCs	SOCs	Hardness	Manganese	Arsenic
Wells 1 & 2	X	X		X	X	X			X			X		X		X	X	X		X
Well No. 3	X	X		X	X	X			X			X		X		X	X	X		X
Well No. 4	X	X		X	X	X			X	X	X	X				X	X	X	X	X
Well No. 5	X	X		X	X	X			X		X	X				X		X		X
Random	X	X		X	X													X		
Stands[2] (26)	X		X																	
Ends[3] (8)[4] D/DBPI							X													
Tier 1 Homes[5] (50+)								X												
AC pipe[6]															X					

[1] Other tests are performed, but not on a regular schedule. The City communicates with DOH regarding waivers and monitoring frequency. Arsenic testing must be increased if detections are recorded above the MCL.
[2] Specific system sampling stands.
[3] At ends of distribution system.
[4] 4 ends are within Redmond's service area and 1 end is on the Seattle side.
[5] Tier 1 homes built 1983–1986.
[6] System area with known AC pipe.

11.6. Emergency Response Program

Emergencies that could impede the supply of water on a short-term basis include such occurrences as pipe breakage, hydrant damage, and short-term power outages. These emergencies are normally anticipated and handled by the water utility staff without significant difficulty.

Less frequently, water utilities must deal with natural and man-made disasters of greater magnitude. These include earthquakes, volcanoes, hazardous material spills, aquifer contamination, vandalism, extended periods of freezing weather, extended droughts, flooding, major power outages, and windstorms. Less extensive emergencies include chlorine leaks, landslides, water system staff strikes, and large mechanical failures.

11.6.1. Vulnerability Evaluation

The City conducted a vulnerability analysis that estimates the degree to which the City's water system might be adversely affected in various emergency situations. This information has been used in the City's emergency preparedness program.

11.6.2. America's Water Infrastructure Act (AWIA)

AWIA requires that all community water systems serving populations greater than 3,300 persons conduct a Risk and Resilience Assessment (RRA) of the risks to, and resilience of, their system, and update their ERP accordingly. The RRA is required to include the following elements:

- Risk to the system from malevolent acts and natural hazards
- Resilience of the infrastructure, including supervisory control and data acquisition (SCADA)/cyber resilience
- Monitoring practices of the system
- Financial infrastructure of the system
- Use, storage, or handling of various chemicals by the system
- Operation and maintenance of the system

Per the AWIA requirements, the City prepared an RRA in 2020 that provides a review of the vulnerability of the City's critical assets, which incorporates risks caused by both natural hazards and human-caused threats, effectively updating the City's 2004 vulnerability assessment. This RRA summary report documents the process and results of the RRA, providing the City with an understanding of which assets in the system are most critical, along with potential mitigation measures that can be considered to address the identified risk in the water system. The City certified its RRA to the administrator of the U.S. Environmental Protection Agency (EPA) by the deadline (March 31, 2020).

The RRA must be reviewed at least every five years to determine if revisions are required because of changes to the water system. Upon review, the water system must recertify the RRA if there are no revisions or certify a revision to the RRA.

The City was also required to update its ERP within 6 months of the RRA certification so that the revised ERP includes information from the latest RRA. The ERP update must also be certified to the EPA. The City updated it's ERP according to the findings of the RRA and certified the document with EPA by the deadline (September 30, 2020). The ERP will be reviewed on the same five-year timeline required of the RRA and updated as necessary. The ERP referenced other related emergency planning efforts and documents prepared by the City, including the City's *Water Supply Contingency and Spill Response Plan* (1997) and the *City of Redmond Risk and Resiliency Analysis* (2020).

11.6.3. Emergency Call-Up

Individual emergencies that are called in by customers are addressed by emergency standby personnel from the Public Works Department. Each of the City's four public works divisions (water, wastewater, stormwater, and transportation) has an employee designated as the emergency standby person. They are all on-call 24 hours a day, seven days a week. Of the four individuals, one is the primary emergency contact person. The primary contact person receives all emergency calls and then notifies the appropriate person to handle the emergency.

Large-scale emergencies that affect the entire City are handled by the Emergency Operations Center (EOC) team. The team is comprised of upper-level management from within the City's staff. The head of the team, the Emergency Preparedness Manager, will typically be the first person contacted in the event of an emergency. Decisions about what actions to take and implementation of those steps are overseen by the EOC team.

11.6.4. Notification Procedures

All emergency situations are reported by calling 911, the City of Redmond Police Department, or the City of Redmond Fire Department. The police/fire dispatcher or 911 operator calls or pages the Public Works standby or "on-call" person.

A line of communication has been established by the City in the event of an emergency where the public, local agencies, or state agencies must be notified of an event affecting the City's water supply. After the initial notification to the EOC team and/or the Public Works emergency standby person, the following individuals will be notified: Lead Water Quality Technician, Operations Supervisor, Operations Manager, Deputy Public Works Director, Public Works Director, Mayor, and the Public Information Officer.

Detailed lists of notification contacts are provided in Appendix A of the ERP.

11.6.5. Response Actions to Specific Events

In the event of an emergency, the City would follow detailed procedures that were first outlined in the *Water Supply Contingency and Spill Response Plan,* and which have subsequently been revised and updated in the 2020 ERP. The City developed incident action checklists for numerous potential emergency events which outline specific emergency response actions for anticipated events. The checklists, as well as core emergency procedures, are in Appendix B of the ERP.

Emergency response to events jeopardizing the supply system could result in a reduction or complete loss of supply quantity and pressure or water not suitable for potable use. Events of

this magnitude may require shutdown of the supply stations and notifying water customers and DOH. The system would require adjustment of system controls as necessary to provide supply from storage facilities if not contaminated. Alternative water sources have also been identified, primarily consisting of emergency interties, which can be relied upon in the event primary sources are unavailable.

11.7. Safety Procedures

The City has safety procedures in place related to traffic control, chemical handling, and equipment operation. There are also a number of training classes offered that are related to safety. Safety training includes working within confined spaces, first aid, traffic control, and CPR. Monthly safety meetings are held to review safety procedures, training, and related issues.

11.8. Cross-Connection Control (CCC) Program

The City has an established cross-connection control program described in RMC Chapter 13.10.

Where a cross-connection or other nuisance currently exists, the customer shall be required to correct the problem within 30 days. In the event that the nuisance is not abated within the prescribed time, or if the nuisance poses an immediate threat of contamination to the public water supply, service from the City water supply system to the premises may be discontinued or terminated. In addition, any person found guilty of any violation defined within the provisions of RMC Section 13.10 shall be guilty of a misdemeanor and subject to penalties defined in RMC Section 1.01.110.

The City currently employs nine certified cross-connection control specialists (see Table 11-1 above). Backflow assemblies are required by the City to be inspected and tested by a Backflow Assembly Tester upon installation. All backflow devices registered with the City are inspected and tested annually by a DOH certified Backflow Assembly Tester.

11.9. Customer Inquiries

Customer inquiries are handled as described in Section 2.5.5. Similar inquiries that are received on a regular basis are seen as indications of areas in need of potential operations or maintenance attention. Recurring inquiries in an area may include pressure or water quality problems. Customer inquiries are addressed directly by the operations staff, who document them as they are received.

11.10. Record Keeping and Reporting

Maintenance and operations records are maintained on a regular basis using Lucity software. Lucity is an asset management program that records work order initiation and project completion. Lucity is also used to actively manage all Water assets based on condition assessments, maintenance needs and criticality of system components.

The Water Maintenance Group's record-keeping procedures are identified below.

- Detailed records of customer requests and complaints are initially logged in through the Customer Service Desk using the City's Q-Alert software. The information is transmitted to Water Operations for resolution.. Data includes customer name and address, date, nature of the call, and final disposition.
- Records of maintenance activities performed on hydrants, valves, meters, air-vacuum valves, pumps, PRV stations, and other system assets are maintained electronically in Lucity. Technicians in the field use tablets to connect to Lucity for record keeping and reporting.
- All hydrant, main, and valve locations are maintained in bound volumes in each service truck, as well as the MOC.
- Tank levels, water system consumption, key system pressures, and a log of each well are continuously maintained by an automated telemetry system at the MOC.
- All water quality information required by the SDWA is recorded by the MOC. Water quality records include bacteria sampling, pH monitoring, fluoride and chlorine levels, and other data. Bacteriological, physical, and chemical test results are kept on file at the MOC for a minimum of 10 years. Other data is retained for the minimum period prescribed by WAC 246-290-480.

Chapter 12: Capital Improvement Program

City of Redmond Draft 2023 Water System Plan DRAFT

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12. Capital Improvement Program

12.1. Development of Capital Improvement Program

The capital improvement program (CIP) is prepared by first identifying projects that address water system needs or deficiencies, as documented in earlier chapters of this plan. In addition, recurring or annual capital projects related to system maintenance have also been included in the list of improvements.

An implementation schedule of the projects was then developed. Generally, projects of higher priority (i.e., those that address current system needs) were scheduled for implementation within the ten-year planning horizon (2023-2032). Projects that serve anticipated future needs associated with system growth, or are less critical to system operation, were scheduled for implementation beyond 2032. Detailed scheduling of the near-term projects was based primarily upon the City's existing forecast of project implementation timelines. Where applicable, the timing of water system projects has been coordinated with sewer and street improvements planned for the same locations.

Planning-level costs for projects identified by the City prior to this WSP update were estimated using the City's cost estimating tool, which provides budgetary-level cost estimates. Generally, each project cost includes the following components:

- **Base construction cost.** Includes all labor and material costs needed to construct a project.
- **Sales tax.** Calculated as 10.1 percent of the base construction cost.
- **Construction contingency.** Takes into account the uncertainties associated with estimating project costs at this planning level. Typically calculated as 30 percent of the total of base construction plus sales tax.
- **Design engineering/geotechnical/surveying/permitting/construction administration engineering.** Includes City and consultant design costs, and other related cost items, such as permitting and construction administration. For most projects, this is calculated as 25 percent of the base construction cost. However, a higher percentage of the base construction cost is used for projects with more complex design or permitting needs.

These elements are summed to determine the total project-level cost estimate for a project, as expressed in 2023 dollars.

Where applicable, design costs are scheduled one year in advance of construction costs, to reflect the phasing typically used for larger projects.

12.2. Planned Projects and Costs

Table 12-1 presents the City's schedule of CIP projects planned for implementation between 2023 and 2032, as well as those slated for implementation beyond 2032. The City has firm project plans and estimated costs for the first six years of the 2023-2032 CIP. Projects anticipated for implementation in the latter part of the ten-year CIP, beyond 2028, do not have firm cost numbers yet and are labeled as TBD (to be determined). The City reevaluates the CIP every year for costs through the forthcoming six-year period and updates its CIP accordingly. In total, the City's 10-year CIP includes approximately $ 45 million in improvements.

Figure 12-1 provides the locations for the major planned improvements. Descriptions of each project follow. Additional maps that display future capital projects are included in Appendix L. The maps include additional detail of the general alignment of piping that developers will be required to install, at their cost, as new development is constructed within the City's service area. These projects are not identified in the CIP and will be completed by developers as needed to provide the infrastructure to serve the associated new growth.

If a development project requires completion of a project listed on the CIP to provide adequate service, the developer will need to complete the improvement at their cost to serve the associated new growth to the adopted standards. This includes replacing undersized pipe or pipe that is at the end of its useful life.

Table 12-1. Capital Improvement Program Table (In 2023 dollars)

CIP No.	Description	Total Project Cost (dollars)	Schedule and Costs (dollars)										Long-term
			2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	
Supply													
S-1	Well No. 4 Rehabilitation or Replacement	100,000	50,000	50,000									
S-2	Groundwater Aquifer Monitoring Network Improvements	294,822			61,655	233,167							
S-3	Groundwater Protection Infiltration Retrofit Program	2,183,567	1,078,663		10,450	364,818	364,818	364,818					
S-4	Well Equipment Upgrades	TBD											TBD
Storage and Pumping													
ST-1	Additional Storage Facilities - Education Hill (8.9 MG)	TBD											TBD
ST-2	Reservoir Painting	TBD											TBD
Distribution System													
D-1	Pipe Replacement Program	3,900,000	100,000	1,200,000	100,000	1,200,000	100,000	1,200,000	TBD	TBD	TBD	TBD	TBD
D-2	PRV and Meter Vault Projects #2 and #3	8,785,037	5,964,522				1,348,942	1,471,573					
D-3	Pressure Reducing Valve Replacement (NE 51st Street Crossing of State Route 520)	25,000	25,000										
D-4	Booster Pump Station Replacements (Education Hill, SE Redmond, Perrigo)	4,073,343						962,709					3,110,634
D-5	Country Route Upgrade (368 ft, 12-in pipe; 11,430 ft, 8-in pipe)	TBD											TBD
D-6	Willows Road Watermain Extension	2,107,242		90,762	272,287	972,592	771,601						
D-7	51st Street Watermain Replacement	1,057,892					439,231	618,661					
D-8	Overlake Access Ramp Watermain	15,000	15,000										
D-9a	AC Watermain Replacement Phase 1 - Viewpoint North	5,551,825			431,047	690,346	637,793	2,500,578					1,292,061
D-9b	AC Watermain Replacement Phase 2 - 2400 179th Avenue	274,358				65,599	127,725	81,034					
D-9c	AC Watermain Replacement Phase 3 - Viewpoint South	5,003,917					171,955	619,448					4,212,514
Kirkland Joint Use Projects													
JU-1	Kirkland South Reservoir Tank Painting and Seismic Retrofit	2,869,236		2,141,078	728,158								
Bellevue Joint Use Projects													
JU-2	Bellevue 40th Street Meter Replacement	143,525					43,296	100,229					
Maintenance and Operations Center													
MOC-1	Maintenance and Operations Center (MOC) - Campus Design	976,545			509,502	467,043							
MOC-2	Maintenance and Operations Center (MOC) - Campus Construction Phase 1	6,000,000					3,000,000	3,000,000					
MOC-3	Maintenance and Operations Center (MOC) - Campus Construction Phase 2	250,000						250,000					
MOC-4	Maintenance and Operations Center (MOC) - Trinity Building Generator	56,737	15,839	40,898									
MOC-5	Maintenance and Operations Center (MOC) - Fuel Storage Tank Replacement	176,366			35,273	141,093							
MOC-6	Maintenance and Operations Center (MOC) - Security Improvements	83,580	18,753	64,827									
Other													
O-1	Portable Generators Replacement	TBD											TBD

CIP No.	Description	Total Project Cost (dollars)	Schedule and Costs (dollars)										Long-term
			2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	
O-2	Control System and Telemetry Upgrade, Phases 2 and 3	4,234,343	1,500,000	2,100,000	634,343								
O-3	Control System and Telemetry Upgrade Phase 4	3,481,308			409,976	975,140	2,096,192						
O-4	Software Upgrades (Utility Billing, GIS, Asset Mgmt)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
O-5	Asset Management Program Development	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
O-6	Novelty Hill AMI	1,712,649	158,421	341,153	909,806	303,269							
O-7	Pavement Management - Avondale Road (NE 90th Street to Novelty Hill Road)	3,642,508		204,895	409,790	409,790	938,747	1,679,286					
O-8	Pavement Management - NE 24th Street (West Lake Sammamish Parkway to 172nd Avenue NE)	7,306,203	697,743	761,175	761,175	2,288,413	2,797,697						
	Annual Totals		8,990,260	6,028,718	4,102,497	5,413,067	9,101,553	11,169,050	TBD	TBD	TBD	TBD	8,615,209

TBD = Cost to be determined when project definition is sufficient to support development of such estimates.

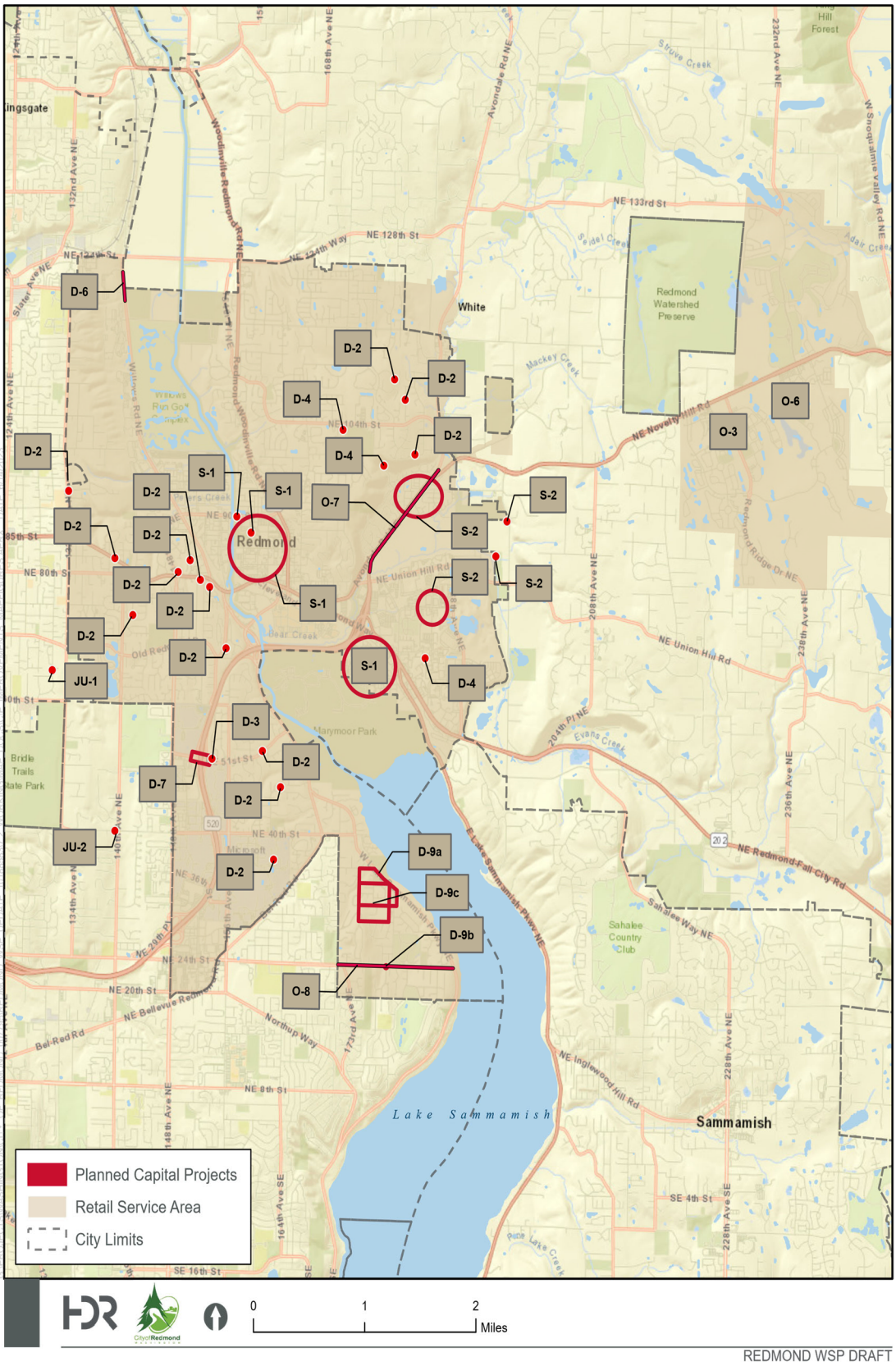

Figure 12-1. Capital Improvement Program Projects Map

12.2.1. Water Supply Projects

The following projects include improvements related to enhancing or protecting existing sources of supply.

- **S-1: Well No. 4 Rehabilitation or Replacement.** This project involves addressing the continued decline in production at Well No. 4. Options to be further evaluated include well rehabilitation, potential drilling of a replacement well, and water rights changes to allow for other wells to be considered as points of withdrawal under the Well No. 4 rights. Funds are budgeted within the 10-year planning horizon for continued study of the issue and identification of a project.

- **S-2: Groundwater Aquifer Monitoring Network Improvements.** Install five to eight new groundwater monitoring wells to monitor the drinking water aquifer. Decommission up to five existing groundwater monitoring wells that have reached the end of their useful lives.

- **S-3: Groundwater Protection Infiltration Retrofit Program.** The City works with private entities to retrofit private stormwater infiltration systems to reduce risk to the drinking water aquifer. This has been an ongoing program and is anticipated to be completed within the next six years.

- **S-4: Well Equipment Upgrades.** Several of the wells will require some level of equipment replacements and upgrades due to the age of the existing equipment.

12.2.2. Water Storage and Pumping Projects

The following projects include improvements related to maintaining existing pumping/storage facilities and construction of new facilities to address future storage volume deficiencies.

- **ST-1: Additional Storage Facilities – Education Hill (8.9 MG).** At the 20-year demand forecast horizon, the City projects a system-wide standby storage deficiency of approximately 8.9 MG in the Well, Rose Hill, and Bellevue-Overlake-Viewpoint Service Areas. Additional storage constructed at the Education Hill tank site can serve to fully address this deficiency. The City has property available at this site for additional facilities, which will likely take the form of two approximately 4.45 MG reservoirs constructed in a phased manner. The timing of reservoir construction will be based upon the rate of demand growth. The City will monitor demand growth and periodically reassess the adequacy of existing standby storage volumes to determine the appropriate schedule for design and construction of new storage facilities. Alternative sites for some of the storage needs will also be analyzed. The 565 zone (also on Education Hill) currently has a single feed and would benefit from an additional storage source and feed.

- **ST-2: Reservoir Painting.** The City's reservoirs should be painted roughly every 15 years. The City will develop a detailed schedule informed by the results of its ongoing strategic asset management program work. At this time, no costs for these activities are budgeted in the 10-year CIP; rather, they are assumed to be incurred beyond the 10-year horizon.

12.2.3. Water Distribution System Projects

The following projects include distribution system improvements, primarily related to piping and valving, that serve to increase fire flow availability in targeted areas, increase overall reliability in the transmission/distribution system, and provide for ongoing maintenance of pipeline facilities.

- **D-1: Pipe Replacement Program.** This ongoing program addresses the replacement of aging, undersized, and/or asbestos cement (AC) water distribution pipes to improve fire flows, minimize emergencies, and prevent catastrophic failures.

Redmond has roughly 53 miles of AC pipe. Figure 12-2 displays the City's current extent of AC pipe. While the pipe remains functional, it is at higher risk of failure due to age and material. Specific segments of AC pipe are targeted for replacement in areas where the City has planned overlay projects, or where there is a known high rate of failure. To proactively address replacement, the City is developing an asset management program that will quantify the appropriate schedule to accelerate work in areas where pipe replacement is the highest priority. Pipe replacement will be prioritized based on age, capacity and risk and impact of failure. Funding for individual pipe replacement projects that have already been identified is included in the City's 10-year CIP. Once an assessment of the system is complete, the schedule for replacement of additional AC pipe sections will be established based on need and availability of funds.

The hydraulic modeling results described in Section 10.4 are used to help prioritize which pipe segments are replaced and the replacement timeline. Figure 10-10 displays pipes that the hydraulic model identified as priorities for replacement or upsizing based on fire flow and velocity criteria. Discrete piping improvement projects are listed in Appendix K.

Furthermore, there are pipes in the system that are undersized based on the zoning for the area the pipe serves. Per Chapter 4 of the City's Water and Wastewater System Design Requirements, water mains serving single family residential zones must be at least 8-inches in diameter, and mains serving multifamily and non-residential zones must be at least 12-inches in diameter. These are not explicitly shown on the CIP table, as selection of which pipe replacement projects occur in certain years is driven by additional factors, including alignment with other City priorities. Figure 12-3 displays AC pipes that are also undersized based on the zoning category of the area they serve and deficient based on hydraulic modeling. These pipes are considered high priority for the pipeline replacement program because they satisfy three key criteria for replacement.

The City budgets an annual amount to support this effort, with project prioritization and selection revisited frequently. The City will focus on prioritizing projects where redevelopment is not likely to occur. Detailed maps displaying the various criteria of pipes identified for future improvements, as well as anticipated developer extensions, are in Appendix L.

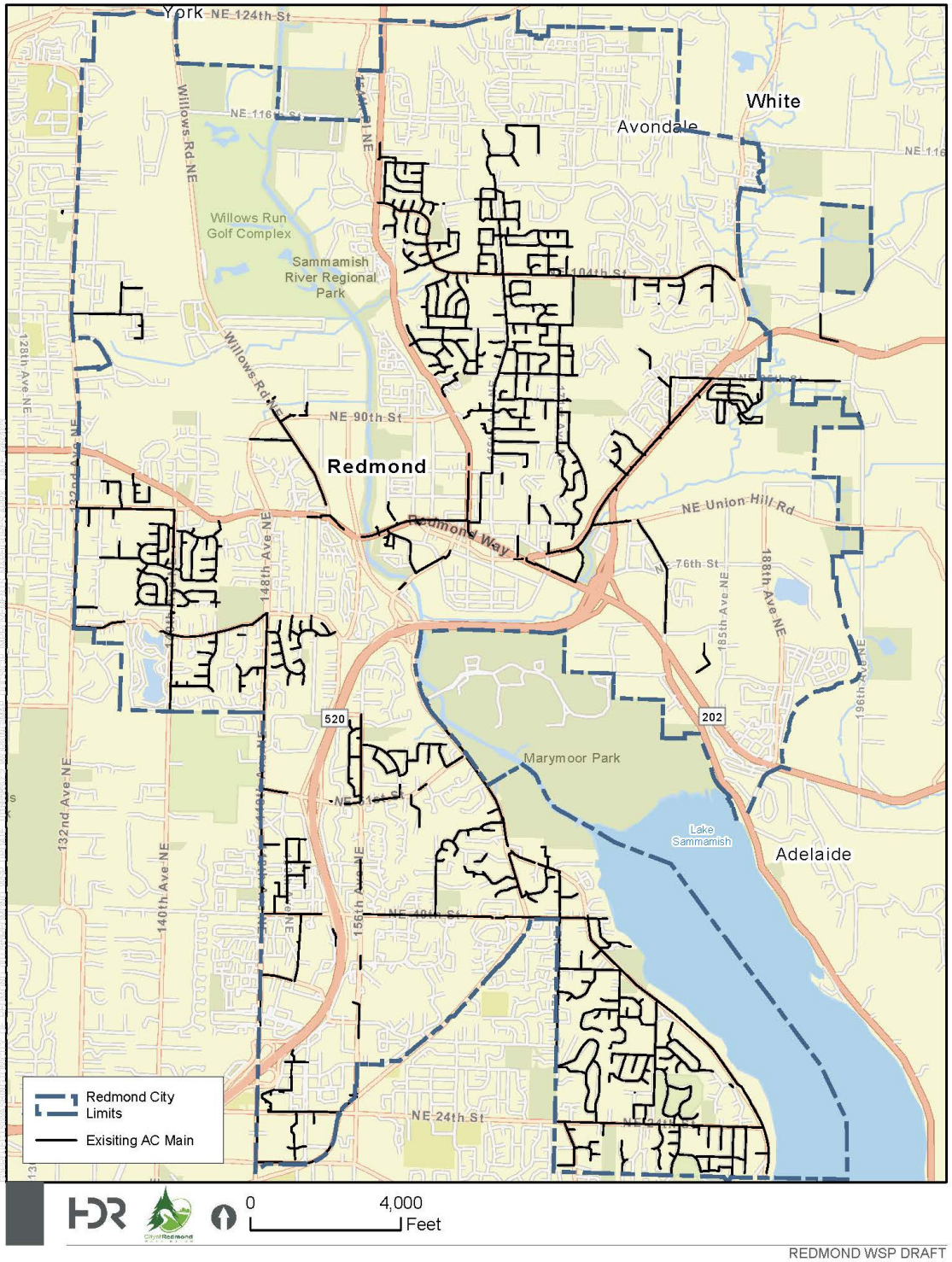

Figure 12-2. AC Watermains in the City's Water System

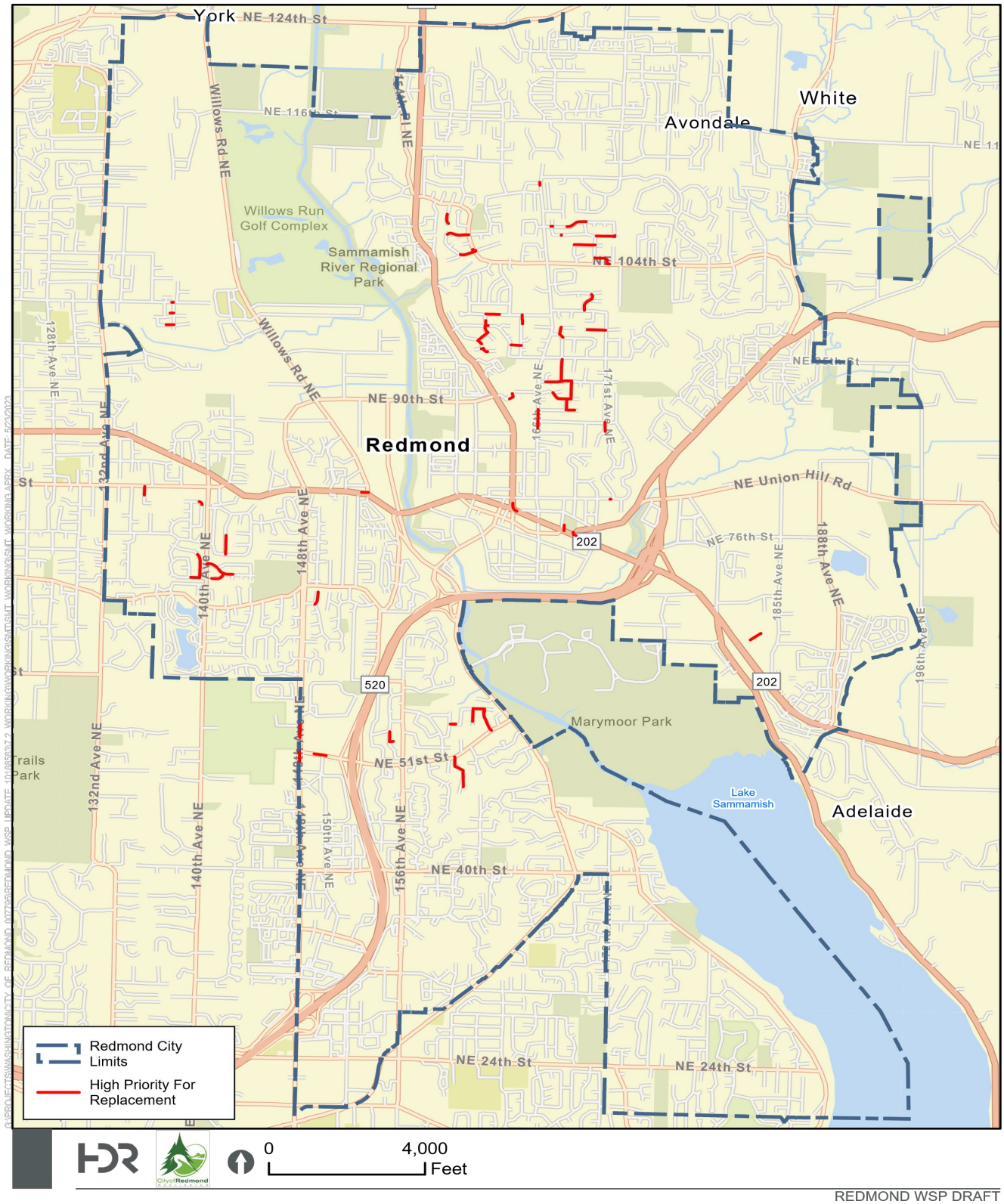

Figure 12-3. High-Priority Deficient Water Mains

- **D-2: PRV and Meter Vault Projects #2 and #3.** This ongoing program involves the replacement of aging and undersized pressure reducing valves (PRVs) and large meters and associated vaults. These replacements significantly reduce the risk of PRV failure which could have a significant impact on customers. Fourteen total PRV replacements are planned.

- **D-3: PRV Replacement – NE 51st Street Crossing of State Route 520.** Replacement of PRV 54 station at 51st east of SR 520.

- **D-4: Booster Pump Station Replacements: Education Hill, SE Redmond, and Perrigo.** Perform a comprehensive system and condition assessment of the City's three booster pump stations. Plan replacements for equipment and facilities identified in the assessment.

- **D-5: Country Route Upgrades.** This project involves upsizing an existing 1920's-era 6-inch dead-end cast iron pipe that extends east along NE Redmond Road toward the Redmond Watershed. The City is planning to work with neighboring purveyors to provide at a minimum one or more additional feeds to the pipe. Ultimately the entire pipe run will need to be replaced due to its age. How that is done may differ from the phases listed below, based on coordination with Woodinville Water and Union Hill Water Association.

    - Phase 1. Replace 368 feet with 12-inch pipe, west of Avondale Road. In addition, replace 3,450 feet with 8-inch pipe, terminating near Farrel McWhirter Park.
    - Phase 2. When needed, replace 4,620 feet with 8-inch, from the end of Phase 1 to the end of NE Redmond Road at 116th.
    - Phase 3. When needed, replace 3,360 feet with 8-inch, from the end of Phase 2 to the terminus of the existing line.

- **D-6: Willows Road Watermain Extension.** Extend the watermain under Willows Road by 1,300 feet to complete the water system for the area and associated frontage improvements. This project supports growth, improves redundancy of the system, and improves fire protection.

- **D-7: 51st Street Watermain Replacement.** Replace the 8" waterline that runs under SR520 with a 12" waterline that runs under the NE 51st Street overpass.

- **D-8: Overlake Access Ramp Watermain.** Replace 8" AC watermain with 12" DI watermain in Shen Street and Hopper Street associated with WSDOT construction of access ramp improvements.

- **D-9: AC Pipe Replacement Projects.** The City has planned three AC pipe replacement projects within the 10-year planning horizon.

    - **D-9a – Viewpoint North.** Remove 3,100 feet of AC watermain that is at the end of its lifecycle and replace it with DI pipe and new services in a portion of the Viewpoint neighborhood. This is the first phase of the Viewpoint AC pipe replacement project. This project will reduce risk of property damage, temporary loss of water service, and fire protection due to watermain breaks.

- **D-9b – 2400 179th Ave.** Replace 960 feet of aging 6-inch AC watermain with 8-inch DI watermain. King County will construct this project as part of the Lake Hills Project. This project will increase the size of watermain to meet current standards, reduce risk of property damage and temporary loss of water service, and ensure adequate fire protection by reducing watermain breaks.
- **D-9c – Viewpoint South.** Remove 3,100 feet of AC watermain that is at the end of its lifecycle and replace it with DI pipe and new services in a portion of the Viewpoint neighborhood. This is the second phase of the Viewpoint AC pipe replacement project. This project will reduce risk of property damage, temporary loss of water service, and fire protection due to watermain breaks.

12.2.4. Joint Use Projects

The following represent improvement projects associated with facilities that are shared with either the City of Kirkland or the City of Bellevue. Costs shown in Table 12-1 reflect only Redmond's share of total project costs.

- **JU-1: Kirkland South Reservoir Tank Painting and Seismic Retrofit.** Improve structural integrity, extend the life cycle, and improve the appearance of a jointly owned and operated water tank. Redmond will provide a portion of funds for the project. Kirkland is considering replacement of the existing tank instead of retrofitting.

- **JU-2: Bellevue 40th Street Meter Replacement.** The City of Bellevue is making safety and equipment improvements to one water meter which Redmond jointly owns with Bellevue. Redmond will provide a portion of funds for the project.

12.2.5. Maintenance and Operations Center

The City has identified six improvements to its Maintenance and Operations Center (MOC) that will be funded through the water CIP through the 2028 CIP planning horizon:

- Campus design
- Campus construction (phases 1 and 2)
- Trinity Building Generator
- Fuel Storage Tank Replacement
- Security Improvements

12.2.6. Other Projects

The following are miscellaneous projects that support ongoing and reliable water system operation.

- **O-1: Portable Generator Replacement.** Purchase of replacement generators to provide emergency power at various sites. Key sites are the Education Hill Pump Station and Reservoir Park.

- **O-2: Control System and Telemetry Upgrade, Phases 2 and 3.** Replace control panels and telemetry communication systems at several in-City water utility facilities. Control panels will be upgraded to current industry standard technology and telemetry communications will be more reliable.

- **O-3: Control System and Telemetry Upgrade Phase 4.** Replace control panels and telemetry communications systems at all Novelty Hill water and wastewater facilities. Control panels will be upgraded to current industry standard technology and telemetry communications will be more reliable.

- **O-4: Software Upgrades.** This refers to periodic upgrades associated with software used for utility billing, GIS, asset management, etc.

- **O-5: Asset Management Program Development.** This refers to various programmatic activities the City anticipates undertaking within and beyond the 10-year planning horizon to support its asset management program.

- **O-6: Novelty Hill Advanced Metering Infrastructure.** Replace water meters in the Novelty Hill service area with Advanced Metering Infrastructure (AMI) meters to improve remote tracking of water usage by customers and the City. AMI facilitates improve customer service, water use efficiency, and operational efficiency.

- **O-7: Pavement Management.** Replace approximately 2,500 l.f. AC watermain (mostly 16") in Avondale Road from NE 90th Street to Novelty Hill Road in preparation for future overlay work.

- **O-8: Pavement Management.** Replace approximately 6,300 l.f. AC watermain (8" and 12") in NE 24th Street from W. Lake Sammamish Parkway to 172nd Avenue NE in preparation for future overlay work.

Chapter 13: Financial Program

City of Redmond Water System Plan DRAFT

Contents

13. Financial Program 13-1

Tables

(Not applicable)

Figures

(Not applicable)

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13. Financial Program

The City of Redmond updated its water utility rate study in 2017 and published it in 2019 (see Appendix L). The rate study is typically updated every two years. Due to the impacts of Covid in 2020-2022, the City chose to not increase rates and did not do a rate study. The City is in the process of updating its water utility rate study, but it will not be complete at the time the Water System Plan is finished. Through this process the operating and capital costs of the utility are thoroughly analyzed to determine the level of rate revenue necessary to appropriately fund operational and capital needs of the utility.

The City also has a biennial budget adoption process which provides for review of revenues and expenditures. Each enterprise fund, including the water utility fund, must be self-supporting and self-sustaining. Information about the City's budgets and budget priorities is available on the City's website on the Finance page: Finance | Redmond, WA

Capital projects are funded through a combination of rates, capital facilities charges, debt and reserves, as well as outside funding sources for special projects. Many of the projects listed in Chapter 12 of this WSP have been included in the City's latest rate projections. Those projects that are new will be included in the next rate projection, and in upcoming biennial budgets at the time the project is needed.

The City has a long history of adequately funding capital improvements and operations of the water utility to maintain infrastructure, safe operating conditions, level of service and to provide the facilities necessary in order to serve projected growth. More information about the City's utility rates and financial policies is available on the City's website: Utilities | Redmond, WA

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